SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1925.

GENERAL PHYSICS.

1784. *Time Comparisons by Coincidence.* **J. P. Henderson.** (Roy. Astron. Soc. Canada, J. 19. pp. 48–58, March–April, 1925.)—Where precision is required, clocks may be compared by the method of coincidence of extinction—that is, when one series of audible signals is encroached upon and extinguished by another series of "opens," no signal being then heard, and personal equation becomes insignificant [see Abstract 708 (1917)]. In this comparison one of the two chronometers produces, electrically, an audible signal which should be of high pitch, so that the time from one peak of the alternating or intermittent electric wave to the next will be small in comparison with the degree of accuracy required; a succession of at least two maximum excitations separated by an audio pitch interval is sufficient to give a sense of musical pitch which can be recognised as a signal. The other and differently rated chronometer, by means of its electrical contacts, opens the circuit at its own seconds and keeps it open long enough to extinguish the whole of the audible signal from the first chronometer. At Ottawa two chronometers have been successively employed, one rated to gain fifteen minutes a day on mean time giving three coincidences in the five-minute time-signals, the other to gain thirty minutes and giving six coincidences. The methods of using a local circuit with wireless time-signals are described both for permanent and field use, and there are given reproductions of actual records of signals from Annapolis and Lafayette (Bordeaux), and a diagram of the circuit in use at Ottawa.
A. S. D. M.

1785. *Specific Gravity of Mercury.* **K. Scheel** and **F. Blankenstein.** (Zeits. f. Physik, 31. 1–4. pp. 202–209, 1925. From the Reichsanstalt.) —The mean value at 0° C. is 13·59549. Two different samples of mercury gave 13·59540 and 13·59558. The specific gravity at temperatures t from 0° C. to 100° C. is

$$13{\cdot}59546\left\{1+\left[18{\cdot}182\,\frac{t}{100}+0{\cdot}078\left(\frac{t}{100}\right)^2\right]10^{-3}\right\}$$

This Abstract is a corrected reprint of Abstract 1282 (1925). A. D.

1786. *Report of the National Screw Thread Commission.* Revised 1924. (Bureau of Standards, Misc. Publ. No. 61 [169 pp.], 1925.)

1787. *Some New Recording Instruments.* **R. S. Whipple.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 455–473, April, 1925. Paper read before the British Assoc., Toronto, 1924.)—The first part describes simple recording mechanisms which depend upon the use of records of very small size obtained by the action of a moving stylus on celluloid films. The records can be read by a microscope to 0·01 mm. or may be projected optically. The stress recorder is actually an extensometer, recording the extension or compression of a 15 in. length of the member to which it is attached. Electromagnetically operated time-markers are provided ; the speed of travel of the film can be varied between 3 and 22 mm. per sec. The instrument can be calibrated by applying known loads to a girder on which it is mounted, and is particularly adapted to recording stresses due to live loads on bridges and similar structures. The vibrograph is a form of seismograph in which the stylus is attached to a heavy mass supported on a knife-edge fulcrum and counterbalanced by a spring. This mass remains at rest while the relative movement of the remainder of the instrument displaces the celluloid film under the stylus to an extent which is a measure of the amplitude of the vibration. For large amplitudes a smaller weight, enabling unmagnified or diminished records to be taken, is provided. The accelerometer records accelerations in vertical or horizontal movements. The relative motion between a spring-suspended weight and the remainder of the apparatus is magnified by a lever carrying the stylus and having powerful eddy-current damping. The natural period is 0·025 sec. In the Moullin torsionmeter, described in the second part, the torque on a shaft is measured continuously throughout the revolution by observing the current flowing through a choking coil, the air-gap of which is varied by the relative movement of two members fixed at a known distance from each other on the shaft. The alternating current is supplied from a small 60-cycle 100-volt 0·2-kw. motor generator, specially designed to eliminate the effect of changes in the supply voltage. In the indicating pattern the mean integrated torque is given by a suitably calibrated ammeter. For recording, the ammeter is replaced by a Duddell oscillograph. Illustrations of all the apparatus and the records obtained are given in the original paper. W. H. G.

1788. *Micrometers and Measuring Instruments. Part IV.* **P. Duckert.** (Zeits. Instrumentenk. 45. pp. 176–185, April, 1925.)—For previous parts see Abstract 1287 (1925).

1789. *Notes concerning the Sprengel Pump.* **J. J. Manley.** (Phys. Soc., Proc. 37. pp. 142–144, with Disc., April, 1925.)—The paper gives an improved design of the modified Sprengel pump described by the author [see Abstract 2394 (1924)]. The walls of the pump are freed from gas skins by electric means, and the shattering of the mercury pellets (which tends to liberate gas) is checked by a special construction of the fall tube. AUTHOR.

1790. *The Elimination of Disturbance in Refined Observations.* **C. V. Boys.** (Journ. Sci. Instruments, 2. pp. 264–266, May, 1925.)

1791. *Electric Maintenance of Pendular Oscillations without Material Contact.* **J. Villey** and **P. Vernotte** (Comptes Rendus, 180. pp. 1100–

1102, April 6, 1925.)—The maintenance of pendular oscillations presupposes the intervention of forces rhythmically attuned to the oscillations and so distributed that they produce a positive effect equivalent to the energy consumed by friction. It is possible to eliminate material contact and any accessory liberating device and to achieve maintenance by electrostatic attractions between the pendulum and its fixed supports, the attractions being regulated by the geometrical configuration of the system. The two conductors between which the electric attractions are exerted constitute a deformable condenser. To bring the forces into rhythmical agreement with the oscillations all that is needed is to set up the difference of potential V between the two armatures by electric oscillations, the circuit being so regulated that the configurations traced by the pendulum approximate to optimum resonance with the impulses of a primary circuit utilised as a source. The couple acted upon by these electric attractions has the form kV^2, k being a purely geometrical coefficient equalling dC/da. This gives for the total work the expression $\int V^2 \frac{dC}{da} da = \int V^2 dC$—that is to say, the area of the curve which represents the square V^2 of the difference of effective potential between the two armatures, in function of the capacity C which they constitute. In a complete swing of the pendulum the figurative point (V^2, C) returns to its initial position. Maintenance requires that the closed curve thus described enclose an area equivalent to the frictional effect and traversed in the direction for which $\int V^2 dC$ is positive. If V^2 be a uniform function of the actual capacity C, the closed curve is flattened, following an arc traversed to and fro; its area is therefore nil and maintenance impossible. For the same configuration, V^2 should be greater when the swing is in the direction of increasing capacities than in the opposite direction. This phenomenon of permanent maintenance may be easily observed by taking as a pendulum the torsion gear of an electrostatic voltmeter, the aperiodicity check being put out of action. E. F.

1792. *Viscosity Measurements with Glass.* **V. H. Stott, Edith Ervine and D. Turner.** (Roy. Soc., Proc. 108. pp. 154–171, May 1, 1925.)—Two types of apparatus were employed, one applicable to the measurement of viscosities from $10^{16\cdot 6}$ to 10^6 c.g.s. units, and the other to the measurement of viscosities between about 10^4 and 10^2 c.g.s. units. Very high viscosities (from 10^9 to 10^{17} units) were measured by applying torsional forces to the two ends of a cylindrical rod of the glass, the latter being heated in an electric furnace and the torsion being localised to a length of 1½ in. at the middle, the diameter there being reduced from ½ to ¼ in. For viscosities lower than 10^9 units the rod would be too soft. In this case the glass is held in a cylindrical container and a cylindrical co-axial rod is plunged into the glass and rotated. In both cases the time required for the moving portion of the apparatus to rotate through a given angle under the action of a known torque is a measure of the viscosity of the glass. The determinations of viscosity at high temperatures have been made by measuring the rate of fall of a partially counterpoised platinum-iridium ball suspended on a wire of the same material. Details of the apparatus and the method of calibration are described fully, and the results obtained for glasses of various compositions are presented graphically. [See Abstract 1243 (1904).] A. W.

1793. *Experimental Determination of Viscosity of Vibrating Solids.* **S. L. Quimby.** (Phys. Rev. 25. pp. 558–573, April, 1925.)—Specimen bars are excited to longitudinal vibration by means of a high-frequency electrical field impressed on a piece of piezo-electric quartz cemented to one end of the bar. The amplitude of vibration is observed by measuring the torque on a Rayleigh disk suspended in air near the other end of the bar. The experimental curves for hard-drawn copper, aluminium and glass are in good agreement with those deduced from theory. The values found for the viscosities of these are Al 545, Cu 2880, and plate glass 2440 c.g.s. units. The speeds of sound in these three solids, obtained from the resonance frequencies, are 5070, 3650 and 5710 metres per sec. respectively, accurate to about 1 %. A differential frequency meter is described, sensitive to a change of less than 1 cycle per sec. in a frequency of 50,000 per sec. E. H. B.

1794. *Capillary Rise in Tubes of Various Metals.* **E. K. Carver** and **F. Hovorka.** (Am. Chem. Soc., J. 47. pp. 1325–1328, May, 1925.)—For water in glass tubes at 20° C. the product radius into height in different experiments varied between 14·85 and 14·89, with a mean value of 14·87. For zinc, copper, silver, and glass in another set the values of this product were respectively 14·85, 14·85, 14·84, and 14·86. E. H. B.

1795. *Surface Tension. Interpretation of the Eötvös Relation.* **L. Brillouin.** (Comptes Rendus, 180. pp. 1248–1251, April 27, 1925.)—The empirical law of Eötvös states that if A is the capillary constant and V_m the molecular volume, $\frac{\partial A}{\partial T}V_m^{2/3}$ is a constant lying between 2·1 and 2·25 c.g.s. for very different liquids. The author explains this law by considering the waves propagated in all directions when a surface molecule is displaced, the waves of compression passing into the interior can be neglected, and the capillarity waves in the surface are considered, which for high frequencies do not penetrate into the interior. The method indicated by Debye is made use of, in which the frequencies are limited on the high-frequency side, so as to obtain the correct number of degrees of freedom, and an expression is obtained for the energy of thermal agitation per unit of surface, *i.e.* of the capillarity waves from frequency 0 to an upper limit ν_e, accumulating towards the limit ν_e. These waves exert a sort of radiation pressure on the linear boundaries of the surface, and it is shown that this leads to the equation $S_m\partial A/\partial T = 9R/4 =$ constant, where S_m is the surface occupied by a gramme molecule of the liquid, spread out into a monomolecular layer, and RT measures the thermal energy of the molecules. This equation closely resembles the Eötvös law, and further discussion gives the equation $V_m^{2/3}\partial A/\partial T = 9RN^{-1/3}/4$, where N is Avogadro's number. The numerical value of the quantity on the right of this equation is 2·2, which agrees with the experimental values of Eötvös. H. N. A.

1796. *Inelastic Impact.* **O. Heimstädt.** (Zeits. f. Physik, 31. 1–4. pp. 72–75, 1925.)—In this mathematical paper the treatment of the phenomena of the inelastic impact is given first, with a relative character of motion, and second with an absolute motion; but according to the impulse theorem both lead to the same result. On omission of the impulse theorem the impact may be evaluated more accurately from their energy contents, reckoned absolutely. E. H. B.

1797. *On the Theory of Elastic Stability.* **W. R. Dean.** (Roy. Soc., Proc. 107. pp. 734–760, April 1, 1925.)—The object of this mathematical paper is to derive equations that are adequate to decide questions of the stability under stress of thin shells of isotropic elastic material. Southwell's work [see Abstract 382 (1914)] in this connection is mentioned. It is assumed that the displacement coordinates of any point of the shell can be expanded in power series of the normal distance of the point from the middle surface. Second-order shell equations can then be deduced from the general equations by using the boundary conditions at the two faces of the shell. The method will in the same way reduce general equations of the first order to the corresponding shell equations. For checking the results of the new method employed by a comparison with known formulæ, the stability of a tubular strut is briefly considered. H. H. Ho.

1798. *Remarks concerning the Work of A. Joffé and M. Lewitsky on "The Tensile Strength and Elastic Limits of Natural Rock-salt."* **W. Ewald** and **M. Polányi.** (Zeits. f. Physik, 31. 10. pp. 746–749, 1925.)—Contrary to the conclusion of Joffé and Lewitsky, who attribute the increased tensile strength of natural rock-salt, when wetted, to surface effects, the authors attribute the phenomenon to effects occurring within the crystal and due to the load. They find that the resistance of rock-salt to plastic deformation at a constant load is reduced when the surface of the crystal is moistened with water. [See Abstract 1298 (1925).]
J. S. G. T.

1799. *The Variation of Young's Modulus at High Temperatures.* **J. P. Andrews.** (Phys. Soc., Proc. 37. pp. 169–176; Disc., 176–177, April, 1925.)—The variation of Young's modulus [see Abstract 2895 (1924)] with temperature is found for zinc, silver, phosphor-bronze, lead, and soda glass by a static method, to within about 150° of the melting-point. For these substances (as for several others recorded) the modulus varies exponentially with temperature, so that q (Young's modulus) $= q_1e^{-b_1}$ (where q_1 and b_1 are constants) up to a temperature roughly half-way from absolute zero to the melting-point, and $q = q_2e^{-b_2t}$ for the remainder. The values of the constants are tabulated. AUTHOR.

1800. *Vibrations of Stretched Membrane with a Particular Law of Density.* **E. L. Ince.** (Roy. Soc. Edinburgh, Proc. 45. 1. pp. 102–112, 1924–1925.)—The law of density of the membranes whose vibration are here studied is given by $\sigma = C(a^2 - r^2)$, where σ is the surface density, r the radius from a fixed point, C and a constants. The constant a is called the *critical* radius and the corresponding circle the *critical* circle. It is the inverse problem which is studied, *viz.* that of determining the law of density so that the membrane may admit of vibrations in a specified mode and of frequency $p/2\pi$. Circular and elliptical membranes are treated and many results obtained for each. E. H. B.

1801. *The Whirling Speeds of Shafts carrying Concentrated Masses.* **R. C. J. Howland.** (Phil. Mag. 49. pp. 1131–1145, June, 1925.)—The whirling speeds of shafts carrying loads whose moments of inertia are negligible were considered by Dunkerley (1894), who proposed a rule for computing the first whirling speed. This was without theoretical foundation, and consisted in finding the whirling speed for the case when all the loads but one were removed, the squared reciprocals of the separate speeds being found in this way, and the sum stated as the squared reciprocal of the whirling speed when all the loads were carried simultaneously. Jeffcott later (1918) gave a theoretical derivation of Dunkerley's rule by a method which enables all the whirling speeds of the loaded shaft to be computed to any desired degree of accuracy. The present paper attacks the problem from a different standpoint. Dunkerley's rule is arrived at by a theoretical method, which gives at the same time a correction term. A numerical estimate of the error involved in using the rule is made. The application of the method to non-uniform shafts is also considered. The paper is entirely mathematical. H. H. Ho.

1802. *The Measurement of Drop Size in Sprayed Liquids.* **W. Heubner.** (Zeits. techn. Physik, 6. 4. pp. 149–151, 1925.)—This paper contains comments on the work of Häusser and Strobl [Abstract 1988 (1924)]. It is shown that the results of these writers suggests certain quantitative relations in connection with the precipitate from sprays. For the comparison of the drop size in different fogs the sedimentation method is suggested. The relation between drop size and pressure is confirmed. A. A. D.

1803. *The Flow of Water in an Inclined Channel of Rectangular Section.* **H. Jeffreys.** (Phil. Mag. 49. pp. 793–807, May, 1925.)—The frequent occurrence in Nature of turbulent flow over a plane or nearly plane surface, with a free surface for the upper boundary, suggested the present direct experimental determination of the coefficient of skin friction and of the Reynolds criterion for turbulence. In Hopf's investigation [see Abstract 1192 (1910)] the coefficient of skin friction was not found when the critical speed was much exceeded, and the methods differ materially from those now described. Observations have been made of the flow of water in an inclined trough of rectangular section with a planed-wood bottom. Defining the Reynolds criterion for such a system as Q/ν, where Q is the total volume flux of water per unit breadth per unit time, and ν is the kinematic viscosity, turbulence is first found to develop when the Reynolds number is about 310, distinctly less than the corresponding number for a pipe. When the Reynolds number is between two and thirteen times the critical value, the observations are consistent with the skin friction coefficient, κ being $0{\cdot}00253 \pm 0{\cdot}00006$, where the frictional force per unit area of the bottom is supposed to be $\kappa\rho u_1^2$, u_1 being the surface velocity. The mean velocity is about 0·94 of the surface velocity. The existence of a layer of water in laminar motion at the bottom of the trough was verified even at the highest velocities tested. The above interpretations have been put on the experimental results on the supposition that a uniform eddy viscosity exists at all depths between the free surface and the non-turbulent layer; on the same hypothesis it appears that the eddy viscosity must be $0{\cdot}0080\ Q$. A theory has been constructed to account for certain travelling waves observed by Vaughan Cornish in steeply-inclined conduits. It appears that the uniform turbulent flow of a stream, with a plane free surface, becomes unstable when the mean slope exceeds 1 in

100, and that it is then replaced by a series of bores travelling faster than the water. H. H. Ho.

1804. *Wind-Channels in Aerodynamics.* **N. K. Bose.** (Phil. Mag. 49. pp. 808–817, May, 1925.)—This paper contains a mathematical discussion of wind-channel experiments in which the experimental body is placed in a current of air rendered free from eddies, and the six components of forces on the body are measured. The quantities that concern wing-measurement most are its lift and drag for different angles of attack and the corresponding positions of the centre of wind-pressure, but these quantities measured in the channel are quite different from the corresponding ones in free space, and constitute the subjects of discussion in the paper, which should be consulted in its entirety. H. H. Ho.

1805. *The Theory of the Drift of Projectiles.* **E. T. Hanson.** (Phil. Mag. 49. pp. 786–793, May, 1925. Communicated by permission of the Admiralty.)—In this paper an extension of the Particular Integral of the approximate equations of motion in air of a spinning shell is discussed. The shell is considered to be a rigid spinning body acted upon by three forces at right angles to one another passing through the centre of gravity, and by three couples about axes at right angles to one another which intersect at the centre of gravity. The following conditions are assured: (*a*) The spin is large or sufficiently so to justify the approximations involved; (*b*) the yaw, *i.e.* the angle made by the shell axis with the tangent to the path of the centre of gravity, is always small; (*c*) the deviation of the path of the centre of gravity from the plane normal trajectory is always small. It is found that under no circumstances can the vertical drift do more than counteract the effect of gravity, nor can the lateral deviation exceed half the maximum value of the vertical deviation except under special circumstances. H. H. Ho.

1806. *The Dissipation Function of Lord Rayleigh.* **B. Finzi.** (Accad. Lincei, Atti, 1. pp. 215–220, Feb. 28, 1925.)—A purely mathematical article, in which the energy dissipated in the movement of a fluid is calculated. The special nature of the article does not allow of abstracting, and the original article should be consulted. E. B.

1807. *The Stabilisation of Instable Equilibrium by Means of Gyroscopic Forces.* **H. J. E. Beth.** (Phil. Mag. 49. pp. 1183–1190, June, 1925.)—The stabilisation, by means of gyroscopic forces, of a mechanism having three or four degrees of freedom is investigated by the method of analysis developed in a previous paper [see Abstract 1308 (1925)] combined with geometrical considerations. J. S. G. T.

1808. *On the Statistical Mechanics of Non-ergodic Systems.* **G. Jaffé.** (Ann. d. Physik, 76. 7. pp. 680–708, May, 1925.)—In a previous paper [see Abstract 2897 (1924)] the author has shown that classical statistical mechanics lead to deviations from the equipartition hypothesis. He now extends the idea of quasi-ergoden therein employed to ergoden of higher orders, and defines an ergode of the *f*th order as a system whose orbit approaches every value of the phase space compatible with the energy integral and the $(f-1)$ further integrals (without respect to time) of the equations of motion. Consideration of the centre of gravity integral with the energy integral (ergode of the 4th order) leads for a mass-point system under conservative forces to deviations from the equipartition hypothesis for the average active force relative to the centre of gravity. If the surface integrals be also considered (ergode of the 7th order), then, according to Maxwell's calculations, further deviations are given from the equipartition of kinetic energy. The above ergode of the 4th order is found replaceable by a suitably constructed canonical distribution of the 4th order. The ergode of the 4th order leads to the pair-hypothesis in the form previously employed by the author, and accordingly is in contradiction with the impact-number hypothesis. If a gas consists of n_1 large masses m_1, and n_2 small masses $m_2 (m_1 >> n_2 m_2)$, the ergoden hypothesis of the 4th order fails when the large masses are mutually independent while the pair-hypothesis still retains its validity. The method of limit invariants previously used by the author has been verified for the ergode of the 4th order. H. H. Ho.

1809. *The Adiabatic Invariance of the Quantum Integrals.* **P. A. M. Dirac.** (Roy. Soc., Proc. 107. pp. 725–734, April 1, 1925.)—The postulate of the existence of stationary states in multiply periodic dynamical systems requires that if the condition of such a system, when quantised, is changed by the application of an external field or by alteration of an internal constraint, the new state of the system must also be correctly quantised. It follows that the laws of classical mechanics cannot in general be true, even approximately, during the transition. The classical laws, however, may be expected to hold during adiabatic change where the system practically remains multiply periodic, and since the quantum numbers cannot change it should be possible to deduce from the classical laws that the quantum integrals remain invariant. Burgers showed this to be the case provided there are no linear relations of the type, $\Sigma_r m_r \omega_r = 0$, between the frequencies ω_r of the system, m_r being integers. In general, however, such relations exist, and the present author now obtains conditions which are rigorously sufficient to ensure the invariance of the quantum integrals in such a form that it is possible to ascertain whether they are satisfied or not without having to integrate the equations of adiabatic motion.
H. H. Ho.

1810. *A Simple Deviation of the Resistance Law for Very Small Spheres in Gases.* **T. Sexl.** (Phys. Zeits. 26. p. 305, April 21, 1925.)—A formula is derived for the resistance law of suspended particles in gases based on Einstein's consideration of the dynamical equilibrium of such spherical particles. The expression found is in agreement with similar ones by Stokes-Cunningham and Epstein. H. H. Ho.

1811. *Some New Properties of Simple Compounds and Different Varieties of the Solid State.* **E. Friederich.** (Zeits. f. Physik, 31. 11. pp. 813–826, 1925.)—Gives the results of a series of measurements of the melting-point and electrical conductivity of a number of nitrides, carbides and oxides; and combining these results with the investigations of K. Becker and F. Ebert on the crystal structure of these compounds the author arrives at certain general conclusions with regard to the solid state, with a classification depending on the activity of the electrons in the component atoms. In the rare gas atomic lattice the atoms have no active outer electrons; other lattice forms are the molecular lattice, as in solid CO_2 and

HCl, in which the electrons of the molecules are for one reason or another unable to act upon neighbouring atoms or molecules; the ionic lattice with electrolytic conductivity; the atomic lattice without conductivity, probably AlN and perhaps other compounds and diamond; the atomic lattice with electronic conductivity due to the free valency electrons, metals, unsaturated metallic compounds; the atomic lattice with electronic conductivity due to the body electrons, as in CdO, Tl_2O_3, PbO_2, where the metal is saturated and the valency electrons presumably cannot take part in the electric conduction; the atomic lattice with super-conductivity, both the valency electrons and some of those from the next layer are assumed to be active, metals, Cd, Tl, Pb—all of these, it is noted, have ten electrons in the last but one, saturated, electron layer. H. N. A.

1812. *On the Calculation of Certain Crystal Potential Constants and on the Cubic Crystal of Least Potential Energy.* **J. E. Jones** and **A. E. Ingham.** (Roy. Soc., Proc. 107. pp. 636–653, April 1, 1925.)—Two methods are already available for calculating the potential energy of any one atom of an infinite cubic crystal due to all those which surround it, when the potential between any two atoms is inversely proportional to the sth power of the distance; the first is by the use of Epstein's formula for the generalised zeta-function in the form of a series of terms involving Bessel functions (this, however, does not seem well adapted to a general treatment of the problem, though it has been used by Madelung and by the authors for special cases); the second method depends on another type of transformation of the zeta-functions, and has been used for special cases by Ewald and by Emersleben. The method used by the authors for the general case is somewhat analogous in principle to the use of the Euler-Maclaurin sum formula for the Riemann zeta-function, a calculating machine having been employed in calculating a series of values of the functions for values of s from 4 to 30 and for $s = \infty$. The law of force is expressed in the form $f = \lambda_n/r^n - \lambda_m/r^m$, and, denoting the potentials of simple, space-centred and face-centred cubics by ϕ_a, ϕ_b and ϕ_c (negative energy), it is shown that, when $m < n$, $\phi_a < \phi_b < \phi_c$, so that such atoms will set in the form of a face-centred cubic crystal in preference to a space-centred, and in a space-centred in preference to a simple cubic crystal. H. N. A.

1813. *Crystal Groups and Crystal Dynamics.* **E. Waelsch.** (Ann. d. Physik, 76. 5. pp. 534–560, April, 1925.)—Works out the properties of the crystal groups in detail and explains Born's crystal dynamics in terms of vectorial algebra. H. N. A.

1814. *A Determination of the Angle between the Cleavage Faces of Calcite by Use of X-Rays.* **H. N. Beets.** (Phys. Rev. 25. pp. 621–624, May, 1925.)—The dihedral angle was determined by measuring the angle through which the crystal must be turned to reflect the MoKα line, first from one cleavage face and then from the adjacent face. Of the six crystals studied, one gave imperfectly cleaved surfaces, one showed slightly rippled faces, the others gave for the mean dihedral angle $74° 55'\cdot 0 \pm 0\cdot 2'$, in excellent agreement with optical determinations. This corresponds to an angle between the edges of the crystal of $\beta = 101° 55'\cdot 0 \pm 0\cdot 2'$. From the coefficients of thermal expansion the change of β with temperature is $d\beta/dt = -0\cdot 051'$ per degree. The volume of a rhombohedron the distance between whose opposite faces is unity comes out 1·09630 ± 0·00007 at 20° C. AUTHOR.

1815. *The Grating Space of Calcite and Rock-salt.* **A. H. Compton, H. N. Beets** and **O. K. DeFoe.** (Phys. Rev. 25. pp. 625–629, May, 1925.)—Grating spaces of calcite and rock-salt are recalculated, using the new values for the crystal densities obtained by DeFoe and Compton, and come out for calcite 3·0291 ± 0·0010 Å. and for rock-salt 2·8147 ± 0·0009 Å. at 20° C. The values for each degree from 15° to 25° are given in a table. These values are slightly greater than those usually given. The remaining uncertainty is due chiefly to that in Avogadro's number. The ratio $D(CaCO_3)/D(NaCl)$ comes out 1·0762 ± 0·0002 (18° C.), which agrees satisfactorily with Siegbahn's value, 1·0764. The uncertainty in this value is chiefly associated with the molecular weights. Absolute wave-length values corrected for refraction.—The correction is made by using an effective grating space slightly smaller than the true value. For the first order from calcite the effective value is 3·0287 and for rock-salt 2·8144 Å., both at 20° C. Using these values the wave-length of $MoK\alpha_1$ line is found (Siegbahn) to be 0·70749 ± 0·00023 Å. AUTHORS.

1816. *The Crystal Structure of Magnesium Fluoride.* **H. E. Buckley** and **W. S. Vernon.** (Phil. Mag. 49. pp. 945–951, May, 1925.)—The powder method was used, with a cylindrical camera of 2·5 cm. radius designed on the lines of that of Bradley [Abstract 1686 (1924)]. The space group found was D_{4h}^{14}, with Mg atoms on a centred-tetragonal space lattice with unit intervals $a = 4 \cdot 660$ Å. and $c = 3 \cdot 078$ Å. The F atoms lie in the same 001 planes as their Mg neighbours, grouped in pairs about them. The distance from Mg to F is 2·07 Å., or nearly the same as that obtained by adding Bragg's later radii for the elements (2·08 Å.). The structure is similar to that of rutile, TiO_2, though the chemical differences appear considerable. H. N. A.

1817. *The Strengthening of Monocrystals by Alloying and Stretching.* **P. Rosbaud** and **E. Schmid.** (Zeits. f. Physik, 32. 3. pp. 197–225, 1925.)—The strength of metallic crystals can be defined by means of the shearing force in the direction of sliding for which plastic deformation begins. This critical shear proves to be practically independent of the simultaneously acting pressure normal to the sliding or basis surface. The increase of the critical shear, or the strengthening due to alloying, has been investigated in the case of zinc alloyed with cadmium, in which case, up to nearly 1·03 % Cd, there were no inclusions of eutectic, but monocrystals of the mixture could be obtained (*Mischkristall*) in which the Cd atoms are supposed to be distributed in the Zn lattice; monocrystals could also be obtained in the case of zinc alloyed with tin, where, however, inclusions of eutectic are found for all concentrations, setting themselves chiefly in layers parallel to the basis surface. The numbers given for the critical shear are in gr./mm.² of the basis surface for pure zinc 94 ± 3, 0·13 % Cd 274, 0·53 % Cd 825, 1·03 % Cd 1150, 0·1 % Sn 244, 0·5 % Sn 313, 1·15 % Sn 322. Experiments were also made on the strengthening of wires of the different alloys by stretching them while cold. H. N. A.

1818. *Study of Fatty Acids and Di-Acids by Means of X-Rays.* **J. J. Trillat.** (Comptes Rendus, 180. pp. 1329–1332, May 4, 1925.)—The author refers to his work on the X-ray examination of the crystallisation of organic bodies (fatty acids) in the form of long chain compounds, and shows how it is possible to obtain extremely thin layers (of the order 1μ) of such crystalline formations on glass. By improvement in the technique of preparing the films (depositing from alcoholic solutions, etc.) the author has been able to obtain extremely sharp spectrum lines up to the seventh order, using only comparatively short exposures. The results are indicated in tabular form for a large number of the fatty acids.

A. B. W.

1819. *Molecular Diameters.* **H. Sirk.** (Phil. Mag. 49. pp. 708–711, April, 1925.)—Molecular diameters are calculated by assuming the closest packing of molecules at the absolute zero, from T_R the critical temperature, D the density of the liquid at the boiling-point, M the molecular weight, λ_i the internal heat of vaporisation for 1 gramme in calories, and L Loschmidt's number, the number of molecules in 1 gramme molecule. The molecular diameter in centimetres is $s \times 10^8 = \sqrt[3]{0 \cdot 184 M^2 \lambda_i / T_R D}$. The value obtained is about 1·37 times the molecular diameter calculated from the dynamical theory of gases. [See Abstract 37 (1925).]

F. J. B.

1820. *What are the World-Geometry Characteristics indicated by the Quantised World-Lines of Electrons of Hydrogen Atoms?* **E. Reichenbächer.** (Zeits. f. Physik, 32. 7. pp. 505–517, 1925.)—A mathematical investigation of the nature of the world-lines of electrons of hydrogen atoms indicates the special significance of the specific time h/m_0c^2 characterising the electrons, the symbols having their customary significance. When the analysis is restricted to circular electronic orbits, the whole series of world-lines is represented by helices drawn on a circular cylinder, and inclined at a constant angle to the generating lines of the cylinder. The period h/m_0c^2 represents the interval after which the electron returns periodically to its initial condition. If such return is impossible, electronic emission or absorption of radiation ensues until new equilibrium conditions are established. The analysis is extended to include electronic elliptical orbits.

J. S. G. T.

1821. *Atomic Model for Hydrogen.* **A. C. Crehore.** (Phil. Mag. 49. pp. 839–888, May, 1925.)—Electrons and the fundamental positive charges are supposed to be rotating spheroids of uniformly distributed charge. From previous investigations it is shown that these spheroids will possess a definite surface tension, and their resistance to deformation can be calculated. The hydrogen atom is supposed to consist of a charge $2e$ positive with a negative electron in contact with it on each side. The ionisation potential represents the total change in energy of the system when one of the electrons is removed. This is the balance of the energy released when the freed electron recovers from the distortion which it suffers when in combination and the extra energy passing into the second electron in the form of a further distortion. Thus the second ionisation potential for hydrogen would be so great that it cannot be demonstrated. Full expressions for the numerical quantities are derived and the constitution of the hydrogen molecule considered. The spheroidal electron is shown to be practically equivalent to a point and ring electron, with subsequent simplification of the mathematical theory. It is assumed that the two atoms in the molecule lie with their axes parallel, being held in this configuration by the electromagnetic forces due to the rotation of the charges about their axes. In this case the atoms will be deformed, the positive charge lying no longer on the axis of the two electrons. Although the displacement is small, it is shown that the deformed atoms will have a considerable effect on the forces between the two atoms, and these forces are developed in series. Although sufficient data are not available completely to describe the hydrogen molecule, it is found that the results suggest a reason for the apparent constancy of order of the distance between nearest atoms in crystals, 10^{-8} cm. Also it appears that the force terms chiefly concerned are the inverse 4th, 5th, and 6th, thus falling into line with deductions from the elasticity of solids. A. Wh.

1822. *Force Within the Atom.* **G. Green.** (Phil. Mag. 49. pp. 1020–1028, May, 1925.)—For space-lattice arrangements a simple inverse-square law does not work. J. J. Thomson suggests $f = \frac{e^2}{r^2} - \frac{ce^2}{r^3}$. Bohr, on the other hand, for his atom stipulates an inverse square law. The author shows that a law of the type $f = \frac{e^2}{r^2} \cos \frac{\rho}{r}$ or $f = \frac{e^2}{r^2} \cos \frac{\rho}{r} + \frac{ae^2}{r^n} \cos \frac{\rho}{r} + \frac{be^2}{r^n} \sin \frac{\rho}{r^n}$ would give an atomic system essentially conforming to Bohr's atom and to quantum theory, while it would also admit of equilibrium positions for an electron within the atom. A. D.

1823. *Balmer Law as an Equation of Motion.* **L. Page.** (Phys. Rev. 25. pp. 429–443, April, 1925.)—An attempt is made to provide an atom in which the radiating electrons have a "uni-frequentic" motion. For this purpose the classical conceptions of the electron and of kinetic reaction are modified. Differentiation is made between the active and passive charge of the electron.

The theory is applied to the case where the mass of the nucleus is finite (two-body problem) and to linear S.H.M., and leads to results identical with those of the Bohr theory. This theory accounts for the emission of series of the Balmer type and also for the absence of radiation in a stationary state. A. B. W.

1824. *Chemical Affinity and Electronic Structure. Part II. The Polar Link.* **B. H. Wilsdon.** (Phil. Mag. 49. pp. 900–911, May, 1925.)—It was stated in a previous paper, dealing with the non-polar link, that an explanation of the polar link followed from the theory there given by the substitution of the Stark-effect, due to an electrostatic field, for the magnetic field effective in the non-polar molecule. [Abstract 1322 (1925).] It is assumed that the frequencies of the valency orbits concerned become synchronised; $E_a = h\,(\nu_1 - \nu_2)$ is a quantum of energy, the available energy of accommodation, where ν_1 and ν_2 are the frequencies of the valency electrons of the combining atoms in their ground orbits. Assumptions are made as to the changes in quantum numbers which define the electrostatic moment, and an expression is obtained for Q, the heat of formation, in terms of the quantum numbers concerned. A table gives the calculated and observed heats of formations of a number of alkali halides, excluding the fluorides, with the assumed values of the quantum factors p of the uncombined atoms, and those q of the two valency electrons after adjustment. Good agreement is obtained. For the manner in which the equatorial and the parabolic quantum numbers are supposed to change to obtain these results the original paper should be consulted. H. N. A.

1825. *A Possible Reconciliation of Bohr's Interpenetration Ideas with Sommerfeld's Relativistic Treatment of Electron Orbits.* **R. A. Millikan** and **I. S. Bowen.** (Phil. Mag. 49. pp. 923–935, May, 1925.)—Previous work has shown that the X-ray doublet laws are valid throughout the whole field of optics. [Abstract 31 (1925).] The identification of the optical and X-ray levels, however, leads to inconsistencies, and it would appear that some modification of the application of the relativity principle is necessary, despite its quantitative success in the interpretation of the spectra of H and ionised He. The authors suggest that the Sommerfeld equation should be retained for the simple nucleus electron system. They adopt the selection principle for all radiation. L_1 like $2s$ is a 2_1 orbit; L_{11} and L_{111} like p_2 and p_1, circular orbits which differ only in orientation. The orbital energies of L_1, L_{111} differ on account of (1) difference of screening, (2) relativity difference. In optics the first is the greater difference, while in X-rays the relativity difference is the larger. A further assumption is that there is some cause acting by virtue of the difference in orientation of the two orbits L_{11}, L_{111}, which increases the energy of the L_{11} orbit to about the amount it would have by virtue of relativity had it been a 2_1 orbit. This cause may be electrostatic or magnetic in origin or a combination of both. With these assumptions Bohr's interpenetration ideas and Sommerfeld's relativity treatment may be retained through the whole range. The existence of the Paschen-Back effect in H with strong magnetic fields is an obstacle, but further experimental work is needed in this direction. L. L.

1826. *Electrodynamics of Point-Electrons.* **J. Frenkel.** (Zeits. f. Physik, 32. 7. pp. 518–534, 1925.)—Difficulties of the theory of the extended electron are very briefly referred to, and a system of atomic electrodynamics, in which protons and electrons are regarded as point centres of force, is developed. It is suggested that special solutions of the Maxwell-Lorentz electromagnetic equations, differing from the usual type of retarded or accelerated potential function, may be of significance in the discussion of the quantum theory. The equations of motion of a point-charge, the transformation of energy, and the problem of the origin of mass are discussed. J. S. G. T.

1827. *The Theory of the Electron.* **H. Reissner.** (Zeits. f. Physik, 31. 11. pp. 844–865, 1925.)—In order to overcome the difficulties which arise when the electron and the proton are assigned definite magnitudes, the author endeavours to work out a new mathematical theory, in which the Maxwell equations are retained, but the elementary charge is regarded as a point-charge of infinite density. The field energy at the point is also infinite, and the singularity consists only of a discontinuity in the first derivative of the potential of the coefficieuts $g-\mu\nu$ of the line element, and in the fact that the circumference of the circle surrounding the point is not to be regarded as zero. Maxwell's energy tensor, however, gives incorrect values to the charge and the mass, and it is necessary here to employ the Einstein field equations, and assume an additional term of the energy tensor which contains the charge as a factor; this term must correspond to infinite density at the point. In order to obtain the known difference of mass between the electron and the proton the additional tensor must be proportional to the potential and to the charge, but the potential at infinity must not be taken as zero, but be assigned a definite value and sign. H. N. A.

1828. *An Attempted Electrolytic Separation of the Isotopes of Chlorine and Magnesium.* **J. E. G. Pilley.** (Phil. Mag. 49. pp. 889–899, May, 1925.)—The method employed is similar in principle to that used by Kendall and White [Abstract 478 (1925)], and no separation of the isotopes was obtained for either of the two elements. Formulæ are obtained for the migration velocities of the ions on certain assumptions. The failure of the method in producing separation is discussed. Details of the methods of chemical analysis employed are given. H. N. A.

1829. *The Propagation of Action in the Ether.* **G. Fournier.** (Rev. Gén. d'Él. 17. pp. 597–603, April 18, and pp. 629–634, April 25, 1925.)—The mathematical theory employed in the author's previous work referring to the theory of relativity is explained [see Abstract 1565 (1925)] and is applied to the derivation of equations relating to the propagation of action in the ether and more especially to what the author terms "double propagation." The equations of planetary motion, of the displacement of the perihelion of Mercury's orbit, and of the deviation of stellar rays in the neighbourhood of the sun are derived, and the author concludes that gravitational attraction is attributable to action propagated through space with the velocity of light. J. S. G. T.

1830. *Limiting Form of the Fundamental Hydrodynamical Equations of the Theory of Relativity on the Assumption of an Infinitely Large Value of the Velocity of Light.* **G. Grünberg.** (Zeits. f. Physik, 31. 7–8. pp. 584–591, 1925.)—The velocity of light being assumed to be infinitely large, the four hydrodynamical equations of the theory of relativity deduced by Herglotz [Abstract 29 (1912)] are transformed into five equations of the classical theory, *viz.* the three Eulerian equations of motion, and the equations of energy and continuity, the two latter being derived from the single relativistic equation of energy. J. S. G. T.

1831. *The Principle of Action applied to the General Theory of Relativity.* **K. Lanczos.** (Zeits. f. Physik, 32. 3. pp. 163–172, 1925.)—In the deduction of the equations of the field in the general theory of relativity, the field is considered as being attributable to the presence of matter, and the R_{ik} relating to the field (R denoting radius of curvature of the field) are chosen as independent variables in place of the g_{ik}. The principal result deduced by the application of the principal of action to the field, regarded in this manner, is that the material tensor T_{ik} is not given by the customary tensorial equation $T_{ik} = 0$, but is derivable from a "vectorial potential," ϕ_i, by means of the equation $T_{ik} = \partial\phi_i/\partial x_k + \partial\phi_k/\partial x_i - (\partial\phi_s/\partial x_s)g_{ik}$. J. S. G. T.

1832. *The Gravitational Field of a Moving Mass Point and the Dynamical Problem of Two Bodies on the Einstein Theory.* **J. Kudar.** (Phys. Zeits.

26. pp. 302–305, April 21, 1925.)—Section I of this mathematical paper determines the gravitational field and for the problem of two bodies derives simultaneous equations which contain cosmical time as an independent variable. Section II discusses at greater length the procedure of Section I. H. H. Ho.

1833. *External Gravitational Field and Internal Densities.* **M. Brillouin.** (Comptes Rendus, 180. pp. 987–992, March 30, 1925.)—The same exterior field may be produced by an infinite number of distributions of internal density. All measurements that can be undertaken are geodesic measurements in the exterior field, and leave the internal distribution indeterminate. For further detail we have to resort to hypotheses, hydrodynamical or elastic or geological. The author develops a nine-line formula for the internal density, of which the first three lines are accessible to geodesic measurements, while the remaining six contain arbitrary coefficients. The selection of these arbitrary coefficients is a matter for hypotheses, to the choice of which the geodesic data themselves are indifferent. A. D.

1834. *A Quantum Theory of Optical Phenomena.* **J. C. Slater.** (Phys. Rev. 25. pp. 395–428, April, 1925.)—An attempt is made to present a consistent detailed theory of optical phenomena on the assumption that atoms radiate or absorb energy continuously in their stationary states, and that transitions influence radiation only in terminating radiation characterising the old state and substituting that of the new. Moreover, atoms are supposed not to change their energy while radiating, but to change it discontinuously on transition. Resonance radiation is identified with radiation carried by spherical wavelets which, by their interference with the external field, also produce absorption. The behaviour of atoms and radiation when interacting is discussed. Einstein's theory of the probability of transition of atoms is accepted and the probability of interruption of coherent vibrations is discussed. The fields of atoms in any state under the influence of an external field consist of spherical wavelets of the frequencies of the quantum lines which the atom can emit or absorb in its stationary state. For emission frequencies, wavelets are emitted even in the absence of any external field; for absorption frequencies, external fields induce wavelets which interfere with the external field to produce the phenomena of dispersion and to transmit resonance radiation in all directions. The assumptions made in the theory satisfy the correspondence principle in that for large quantum numbers the field approaches that which would be emitted on the classical theory, on account of the interaction of an external field and a multi-periodic atom. Moreover, the field is of a character essentially that of classical electron theory. The energy and momentum relations in the interaction of atoms and light are investigated, and it is shown that though these quantities are not precisely conserved, the assumptions referring to atomic and radiation processes are such that energy and momentum are conserved over a great number of atomic processes. The theory, applied to the spectral resolution of emitted and absorbed radiation, gives a minimum width of the lines, and it is shown that emission and absorption lines have the same width. The theory is also applied to the phenomena of resonance potential and scattering, etc. J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

1835. *The Problem of Warm Polar Climates.* **C. E. P. Brooks.** (Roy. Meteorolog. Soc., J. 51. pp. 83–91; Disc., 92–94, April, 1925.)—The present severity of arctic climates being connected with the existence of large quantities of floating ice, the author deals first with the conditions under which the ice is formed. Figures are obtained which represent very fairly the present conditions in the Arctic Ocean. Application of F. Kerner-Marilaun's figures leads to the result that if from any cause, such as a difference in the amount of solar radiation or in land and sea distribution, the akryogenous winter temperature over the Arctic Ocean was only as much as 4° or 5° F. above the present, there would be a complete absence of floating sea ice, and the actual winter temperatures of the Arctic would be about 30° F. higher. Using Kerner-Marilaun's figures and recalculating on an akryogenous basis for the middle Eocene and Upper Jurassic periods, temperatures are obtained quite consistent with the remains of the vegetation discovered by geologists. Evidence is set out for the existence of a mild climate in the Arctic up to about 900 B.C., when an abrupt change occurred. The possibility of the Arctic Ocean being ice-free about A.D. 500 to 1000 or 1100 is also dealt with.

In the *Discussion* **H. Jeffreys** referred to the astronomical theory of climatic variations and the small effect left by astronomical causes on geological records. **L. C. W. Bonacina** showed that Wegener's theory of continental drift was necessary in some parts to account for some large climatic changes. R. S. R.

1836. *Monthly Pressure and Temperature Anomalies over the Earth. Correlation of Pressure at Iceland with other Places.* **F. M. Exner.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 7–8. pp. 307–408, 1924.)—The present work forms an extension of earlier calculations [Abstract 605 (1914)] to cover a longer period, 1887–1916, and to cover the whole earth. Results have been obtained from 71 stations for pressure and 72 for temperature, mainly from year-books, but a quantity of hitherto unpublished information was used. Mostly results were available over the whole 30 years for each place, but in a few cases corrected results from neighbouring stations were introduced. In parts of the S. hemisphere and between the equator and 10° N. shorter series had to be employed. Over the whole series for pressure and temperature deviations from the mean were obtained for each month and for the year, the deviations being called anomalies. These results are set out by arranging the stations in belts of 10° of latitude. Charts give the geographical distribution of the pressure and temperature anomalies in February and August. In February pressure anomalies in the N. hemisphere are a maximum, but in the S. hemisphere a minimum, the reverse holding for August. Temperature anomalies for the S. hemisphere are greatest in August and least in February, the reverse holding for the N. hemisphere. The regions where pressure and temperature anomalies have their greatest values are called centres of action. The three most prominent of these regions are those where influxes of polar air are likely to occur, *i.e.* the northern part of the N. Atlantic, N.W. Asia, and the Behring Straits, the first of these being subdivided into the Icelandic and the Labrador regions. Finally, the pressure at Stykkisholm, Iceland, the place with the maximum pressure anomalies, is correlated with that at each of the other 70 stations for each month in the whole period and for the winter and summer half-years, *i.e.* October–March and April–September, these two latter being charted. A summary shows a large negative correlation in the region 30°–50° N. existing throughout the year, but generally in S. latitudes the correlation is small. Further work is contemplated over the regions of zero correlation. An appendix gives the source of the information for each station and values of the pressure and temperature anomalies for each month and year of the series and also 30-year mean values for each month, the stations being arranged in alphabetical order. R. S. R.

1837. *The Resistance of the Earth Surface to the Wind.* **E. Oddone.** (Accad. Lincei, Atti, 1. pp. 308–311, March 15, 1925.)—When the wind flows through a valley which is straight at its extremities a minimum of barometric pressure is observed at the entrance and a pressure-rise at the exit. This fact was, for instance, observed in the Marschfeld valley, at the west entrance of which is Vienna and near the exit is Presburg. When the wind comes from the west a pressure diminution can be observed in Vienna and an increase in Presburg. The air in the valley behaves as an incompressible fluid up to a certain point. The author gives an example of a mechanical analogy with the facts observed. E. B.

1838. *Groups of Drops in Clouds.* **H. Köhler.** (Meteorolog. Zeits. 42. pp. 137–143, April, 1925.)—An alternative form of expression is obtained by which the size of a group of drops can be dealt with more readily. [Abstract 117 (1923).] Measurements were made of coronæ at the Haldde Observatory, which gave results in good agreement with microscopic and other optical measurements of the drops at the same time. Subsequently the measurements were extended in a large number of cases to fogs, to stratus, strato-cumulus and alto-cumulus clouds and to rain and snow-falls. For each set a theoretical relation was set out, and it was established that two groups tend to predominate in the clouds. If other groups occur they will be much less frequent. The results are compared with those obtained by Defant and Hartman. The author found two series: 1, 2, 4, 8 for falling rain, and 3, 6, 12 for free drops in clouds. In the former, increase in the size of the drops probably occurs by the union of groups of 2 drops, and so on. Since the vapour-pressure of the larger drop is less than for the smaller, condensation occurs at the union. Thus probably the groups are not equally stable, and one group will exist more frequently during precipitation. The different groups also must be in separate layers. R. S. R.

1839. *Coronas and Iridescent Clouds.* **C. F. Brooks.** (Monthly Weather Rev. 53. pp. 49–58, Feb., 1925.)—The author reviews a large amount of published information relating to coronas and iridescence, and supplies in addition a considerable series of observations and measurements made by himself at Worcester, Mass. These relate to circular coronas and in a smaller number of cases to others which were distinctly non-circular or irregular. Iridescence on clouds he considers as merely a mixture of portions of coronas of different radii. Where the mixing is regular, banding appears parallel to the edge of a lenticular cloud, but an irregular mixture would occur in the interior of a thin cloud with parts of different ages or in wisps of Fr.Cu. Iridescence on Fr.Cu., while showing a connection with the rapidity of cloud formation and evaporation, is also related to the temperature of the cloud. A critical examination of theories introduced to explain the formation of coronas and iridescence inclines the author to diffraction by small water droplets, and not ice crystals, as the cause. Finally, the possible use of the brilliance and angular extent of the colour in these phenomena as a means of determining the temperature at the cloud layer, and thus the probable height of the cloud, is investigated. R. S. R.

1840. *The Changes of Temperature in the Lower Atmosphere by Eddy Conduction and Otherwise.* **S. Chapman.** (Roy. Meteorolog. Soc., J. 51. pp. 101–116; Disc., 116–120, April, 1925.)—The investigation is based on the series of hourly observations of temperature during the five years 1890–1894 at four different heights on the Eiffel Tower. The data have been discussed previously by G. I. Taylor [Abstract 237 (1918)] and by W. Schmidt, the former assuming that eddy conduction was solely responsible for the temperature changes, and the latter that radiation also played a part, although the radiative part of the temperature variation was independent of height. In the present paper the causes are investigated mathematically by dealing with the corresponding potential temperatures. To reduce the data to more manageable proportions the hourly values of temperature were combined into two groups of four calendar months each, May–August (summer) and November–February (winter). The values of eddy conductivity obtained are smaller than those obtained by Taylor. The author concludes that (1) the temperature changes brought about by eddy conduction in the given layer are the smaller part of the whole temperature changes, and particularly so at the lowest levels; (2) the conductive and radiative temperature changes are distributed differently in time, the former attaining their maximum at or soon after midday, while the latter reach their maximum at about 7 hr. in summer and 10 hr. in winter near the ground; and (3) the radiative temperature changes diminish fairly rapidly with increasing height, and their epochs are progressively retarded. In the *Discussion* **F. J. W. Whipple** suggested the advisability of using separate results, not merely for cloudy or clear days, but for individual days. **D. Brunt** suggested possible errors in the Eiffel Tower observations arising from heating of the tower and defective ventilation of the thermographs. The use of temperatures from thermometers exposed near to tall W.T. masts was emphasised as desirable. R. S. R.

1841. *A Remarkable Sixteen-Yearly Climatic Period and Other Possible Periods.* **A. Wagner.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 169–224, 1925.)—The author has first investigated the temperatures obtained at Vienna over the interval 1776–1919, and is able to confirm the existence of a period of sixteen years for the temperature difference between the summer and the preceding winter. The results are extended when examining a series of stations in Middle and South Europe, but along a line Stykkisholm–Stockholm–Petrograd this period is lost. South of this line the phase is the same as that at Vienna, but north of the line it is reversed. The amplitude is a maximum in Mid-Europe and decreases gradually north and south. Stations in Mid-Europe and those in the north show the sixteen-yearly period in both summer and winter mean temperatures, but with opposite phases, and the winter amplitude is about double the summer one. At the maximum of the period in Middle and South Europe a severe winter and a warm summer occur, and these relations are reversed at the minimum. At mountain stations a larger amplitude is found than for a valley station in the same latitude. In an appendix, periods of 33·8, 3·5, and 3 years are investigated for the same series of observations. The Vienna periodograms confirm the existence of the 33·8 and 3 yearly periods for the same temperature difference as used above, but for other European stations it is less definite. In the region where the sixteen-yearly period is lost and its phase reversed, an eight-yearly period is very probable, but for other parts of Europe this period cannot be detected with certainty. R. S. R.

1842. *If the Earth Went Dry.* **N. Shaw.** (Roy. Meteorolog. Soc., J. 51. pp. 77–78; Disc., 78–81, April, 1925.)—The paper consists of a summary of an address before the British Association in Toronto, 1924. [Abstract 302 (1925).] The discussion mainly centred upon details of the operation of convection in producing vertical motion in the atmosphere and upon the undetermined effect of water-vapour upon the diurnal variations of temperature over dry tropical regions. A. W. L.

1843. *The Cooling of the Earth.* **H. Jeffreys.** (Nature, 115. pp. 876–878, June 6, 1925. Basis of lecture delivered before the London Mathematical Soc., April, 1925.)—Starting from the stage when the earth was fluid, the author deals with its subsequent solidification and cooling. Kelvin's theory required modification in view of the change of melting-point with pressure and of the different densities of the constituents of the earth, and later again on account of radio-active discoveries. Calculations by Holmes and Adams regarding the depths of various types of rock to give the observed temperature gradient, under different assumptions regarding the change of radio-activity with depth, are applied to obtain the age of the earth. R. S. R.

1844. *The Chemical Composition of the Earth.* **H. S. Washington.** (Am. J. Sci. 9. pp. 351–378, May, 1925.)—The paper forms a continuation of earlier work. [See Abstract 808 (1925).] Tables are given showing the volumes, masses and densities of the central core and the successive shells composing the whole earth. The component elements in each shell and their percentage amounts are dealt with, while this composition is further expressed in the form of oxides and minerals. The question whether all or part of the metallic Fe was originally present as such or as ferrous silicate is considered, and the conclusion is drawn that about 30 % of uncombined Fe occurred in the original mass out of which the earth coalesced. Finally a comparison is drawn between the composition of the sun's atmosphere estimated spectroscopically, that of the whole earth, and of the earth's crust. A very full bibliography is given. R. S. R.

ASTRO-PHYSICS.

1845. *The Physical Condition of Stars.* **A. Brill.** (Zeits. f. Physik, 31. 10. pp. 717–745, 1925.)—The characteristics of stars from which their physical condition may be deduced—such as spectral type, temperature, absolute magnitude, diameter, and density—are discussed in detail; and, although the observational material is scanty, it is attempted to find laws to connect these characteristics separately for dwarfs and giants. The quantities used by Eddington in his theory of radiation-equilibrium—*viz.* the radiant energy ϵ produced per gramme of matter in unit time and the mass-absorption-coefficient k—are found to bear the simple relation to one another that the product $k\sqrt{\epsilon}$ is almost constant for all stars. It is pointed out that this constancy results from the fact that the difference in radiation temperature between stars is not very large (about 3000° to 30,000°), and that the difference in mass is also mostly small.

M. A. E.

1846. *The Star-Cluster Messier* 11. **R. J. Trumpler.** (Lick Observat., Bull. 12. No. 361. pp. 10–16, 1925.)—This cluster, lying in the Milky Way, is in appearance intermediate between the globular and the open clusters, and has been so differently described by different observers that a special study seemed desirable. It contains about 500 stars brighter than the sun, mostly belonging to type A, and these are so highly concentrated towards the centre that each is separated from its nearest neighbour, on an average, by one light-year only. The fainter stars of the cluster are not so highly concentrated, and must be dwarfs. The distance is about 4000 light-years, and the diameter about 18 light-years. It undoubtedly belongs to the class of open galactic clusters, and closely resembles Messier 37, which was studied by Zeipel and Lindgren.

M. A. E.

1847. *Absolute Magnitudes and Parallaxes of* 1105 *Stars.* **R. K. Young** and **W. E. Harper.** (Dominion Astrophys. Observat., Publ. 3. 1. [143 pp.], 1924.)—Individual parallaxes are given for 1105 stars of types F to M and a few A-type, by the spectroscopic method by means of a single-prism instrument giving a dispersion at H_γ of about 29 Ångströms per millimetre. Fourteen lines are used, five having been those previously used at Mt. Wilson, and a description of the behaviour and character of each is given in pp. 8–10. It is shown how a standard scale is made and used. In determining types, for those earlier than F, the ratio is used of the K line to H_γ or $H + H_\epsilon$, as given by Harvard for the various divisions. If the star is definitely F0 or later, the ratio of $\lambda 4227$ and H_γ is taken. These lines are equal in F8, so for later stars the absolute strength of $\lambda 4227$ up to and including K9 is employed. At about this class, $\lambda 4227$ has its maximum strength, and weakens in the later M types. If the criteria show the star to be as late as K5, titanium oxide bands are looked for, and if there, the star is placed in type M; if not there, in type K, its exact place being given by the strength of the calcium line $\lambda 4227$. No special class was formed for the Cepheids or *c* stars. Empirical curves are formed relating line intensity to absolute magnitude by a series of approximations. A new formula ($\pi = \mu(0{\cdot}089V_0^2 + 17{\cdot}82 \sin^2 d)^{-1/2}$), connecting parallax with radial velocity, total proper motion, and distance of star from the apex, gives consistent results. Comparisons with proper motion data are available for 920 stars. The probable error based upon residuals from 128 stars of best determined parallax is ± 0·4 magnitude, but these are mostly dwarfs. The catalogue occupies pp. 48–141, and four plates of different type spectra are given. A. S. D. M.

LIGHT.

1848. *Absorption of Ultra-violet Light in Dilute Solutions.* **C. J. W. Grieveson.** (Phil. Mag. 49. pp. 1006–1020, May, 1925.)—Nitrates absorb readily, one part in a million producing a measurable absorption in a depth of 10 mm. Phosphates and carbonates absorb fairly well, chlorides and bicarbonates require much stronger solutions, and sulphates absorb scarcely at all. A. D.

1849. *The Biological Action of Light.* **L. Hill.** (Nature, 115. pp. 642–645, May 2, 1925. Substance of two lectures delivered at the Roy. Inst., March, 1925.)—A brief description of the radiation scale is followed by variations which occur in the absorbtion of heat and visible light by the human skin. Sonne's view that the curative effects of light may be attributed by the formation of antibodes has been shown by Hartley to be incorrect. An increase of homo-bactericidal power is, however, produced by light radiation. The small penetration into the human tissues by ultra-violet light is then considered. The tissues subjected to light undergo an aggregation of particles of the bioplasm, and this is discussed from the point of view of electron-atomic theory. Standardisation of ultra-violet light treatment by bactericidal dose, erythema and methylene-blue methods are described. The therapeutical applications to the treatment of rickets in relation to the vitamine theory are discussed, and also the protective mechanism of the body against excessive radiation. Evidence is given for and against the view that infra-red, visible and ultra-violet rays are mutually antagonistic in their reactions, and the effect of ultra-violet light upon growth is considered in relation to the more general establishment of ultra-violet light clinics and the use of ultra-violet transparent glass. B. J. L.

1850. *Radiation Diagrams of Small Dielectric Spheres.* **H. Blumer.** (Zeits. f. Physik, 32. 2. pp. 119–134, 1925.)—On the basis of Mie's exact formula, the intensity of the light dispersed in all directions from dielectric spheres of diameters ranging from $0\cdot032\lambda$ to $3\cdot2\lambda$ and of refractive indices ranging from $1\cdot25$ to infinity is calculated and represented graphically. If ρ is the diameter of the sphere, m its refractive index, and λ the wave-length of the light, the ratio $\frac{2\pi\rho}{\lambda}$ is termed a and the product ma is termed β. With values of a up to 1 and for all the different values of the refractive index, Rayleigh's well-known law of intensity distribution with two minima at $\gamma = 90°$ and $270°$ and two equal maxima at $\gamma = 0°$ and $180°$ is obeyed. When, however, the refractive indices have values between $1\cdot25$ and $1\cdot5$ the intensity of the light dispersed in the direction of the continuation of the ray is greater than in the opposite direction, and the Rayleigh symmetry is disturbed; an exception occurs when $\beta = \infty$ for small values of a, the reverse then being the case. Between $a = 1$ and $a = 2$ new maxima and minima emerge, and from $a = 3$ to $a = 10$ these increase rapidly in apparently regular fashion. The intensity of the light dispersed in the direction of the incident ray is far greater than that in the opposite direction. This observation agrees with the experimental results of Schaefer and Merzkirch [Abstract 1450 (1923)], Schaefer and Wilmsen [Abstract 2576 (1924)], and Senftleben and Benedict [Abstract 1017 (1919)]. Gans [Abstract 1072 (1925)] obtained a similar result, but, with the assumptions he made for the magnitude of the particles and for the refractive indices, could not confirm it theoretically; possibly his medium contained large particles not allowed for in the theoretical considerations. As regards the polarisation of the dispersed light, the diagrams showing the percentage polarisation exhibit, for small values of α and hence also for small particles, a certain symmetry. For some values of the refractive index and size of particle there occurs displacement of the polarisation maximum of 90° towards the region of increasing γ and also in the opposite direction. The larger the particles become, the more irregular is the polarisation, so that several positive and negative polarisation maxima and minima may appear and the degree of polarisation in all directions undergo marked alteration. T. H. P.

1851. *A New Spectral Apparatus, Monachromator and Quartz Spectrograph with Crossed Prisms to Obtain the Highest Spectral Purity for the Region* 200 $\mu\mu$ *to Beyond* 800 $\mu\mu$. **C. Leiss.** (Zeits. f. Physik, 31. 7–8. pp. 488–495, 1925.)—The usual forms of spectral apparatus permit a certain amount of extraneous light to reach the eye-piece or photographic plate. Earlier patterns usually consisted of two parts, and led to complication, but in the present form it is combined into one piece of apparatus. It consists essentially of an entry tube, a dispersion system and an exit tube, with the difference that the secondary slit of one part forms at the same time the primary slit of the second part. In the dispersion system a constant deviation of 90° is obtained, using flint glass prisms for the visible region and quartz prisms for the ultra-violet region, the prisms being mounted on metal tables for rapid and easy interchange. For the ultra-violet region achromatic quartz fluorite lenses are used, and for the other parts quartz lenses. The dispersion system has a measuring or adjusting device for use over a wide range of wave-lengths. For work on the solar spectrum a filter of Br vapour is used to obtain the maximum intensity for the ultra-violet region. The methods of calibration and use of the instrument in the infra-red, visible, and ultra-violet regions are explained. R. S. R.

1852. *A Universal Polarimeter.* **C. A. Skinner.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 491–520, April, 1925.)—The general form of the vibration of polarised light being elliptical, any instrument which measures both ellipticity and azimuth may be called a polarimeter. This name is, however, commonly given to the instrument which measures simply the azimuth of plane polarised light, that which measures ellipticity being designated as an elliptic analyser. The instrument here described, being adaptable to either type of measurement, is called a universal polarimeter. Its construction is shown in numerous figures and illustrations, and its working theory in extensive mathematical calculations. The original paper should be consulted, as it is impossible to do it justice in a short abstract. E. F.

1853. *Rayleigh Interferometer.* **B. W. Clack.** (Phys. Soc., Proc. 37. pp. 116–129, with Disc., April, 1925.)—An account is given of the use of a

Rayleigh interferometer in a series of subsidiary experiments conducted in connection with a recent determination of the diffusivity of solutions of salts in water. The theory of the instrument, as affected by the different dispersions of the various media traversed by the light rays, is studied, and the observations are corrected so as to apply to the green mercury light $\lambda = 5461$ Å., which was employed in the experiments on diffusion.
AUTHOR.

1854. *Correction to Paper "A Test of the Classical Dispersion Formula for Monatomic Gases and Vapours."* **K. F. Herzfeld** and **K. L. Wolf.** (Ann. d. Physik, 76. 6. pp. 567–570, April, 1925.)—J. Koch has called the attention of the authors to the fact that the values of his results given by them [see Abstract 1070 (1925)], and which were taken from a text-book, are full of printers' errors. A new single-term formula is given, which expresses Koch's values within the limits of error stated by him. The natural frequency corresponds to a wave-length 484 Å., which is 19 Å. on the ultra-violet side of the series limit 503 Å.; the resonance line at 584·4 Å. does not appear in this formula. A pair of 2-term formulæ are also derived, each of which agrees with the observations quite as well as the single-term one. The general conclusions of the original paper are not altered, but a number of numerical corrections are necessary.
H. N. A.

1855. *Quantum Theory of Scattering and Dispersion.* **A. Smekal.** (Zeits. f. Physik, 32. 3. pp. 241–244, 1925.)—The basis of "anomalous" scattering is independent of quantum theory. By introduction of "meta-stationary" quantum conditions the change of velocity of propagation in a dispersing medium can be explained, and the phenomena of scattering can be brought under Einstein's probability law, originally formulated for stationary conditions.
A. D.

1856. *Polarisation of Scattered Light and Molecular Optical Anisotropy.* **K. R. Ramanathan.** (Roy. Soc., Proc. 107. pp. 684–693, April 1, 1925.)—It is assumed that each atom in a molecule is isotropic, but that the mutual reactions of the doublets induced by the incident light make the molecule behave anistropically as a whole. From an application of Rayleigh's theory and the known values for the optical quantities in hydrogen, oxygen and nitrogen, the atomic refractivities and the distances between the optical centres in the molecules are calculated. Good agreement with values deduced from the kinetic theory is obtained. The theory is also extended to the compounds nitrous oxide, carbon dioxide and carbon disulphide. The imperfection of polarisation of the scattered light calculated for these on various assumptions as to the structure of these molecules agrees satisfactorily with the observations.
A. Wh.

1857. *On the Polarisation of the Light Scattered by Organic Vapours.* **A. S. Ganesan.** (Phil. Mag. 49. pp. 1216–1222, June, 1925.)—Describes the apparatus used and the experimental details, giving tables showing the amount of polarisation of the scattered light—*i.e.* the ratio of the intensity of the weak to that of the strong component—for paraffins and unsaturated hydrocarbons, alcohols, benzene and four of its derivatives, formates and acetates, chlorine substitution products of methane, ketones, carbon disulphide and ether. Passing from pentane to octane the molecules become longer, and an increase of optical anisotropy might therefore be expected; there is, however, no increase in the depolarisation—if anything there is a tendency to an actual decrease. Where a double bond occurs the factor of depolarisation is high, as in the case of amylene, which has nearly twice the value as for the paraffin series; the depolarisation in allyl alcohol is much greater than in the monohydric alcohols. Iso-compounds have a smaller optical anisotropy than normal ones. Benzene, toluene and xylene show nearly the same depolarisation, the influence of the closed chain of six carbon atoms is predominant; the substitution of CH_3, Cl or Br for H has little effect. Methyl compounds always show a greater depolarisation than ethyl ones; this is seen in the case of formates, acetates, alcohols and ketones. H. N. A.

1858. *On the Tyndall Phenomenon.* **A. Carrelli.** (Accad. Lincei, Atti, 1. pp. 430–435, April 19, 1925.)—A note explaining analytically the Tyndall phenomenon, taking place when a rectilinearly polarised ray of light traverses a body in a state of perturbation. If the disturbance is less than a certain value, the diffused light is rectilinearly polarised perpendicularly to the incident ray, whilst if the trouble exceeds a certain value, it is polarised in a direction parallel to the ray. The analytical treatment of this problem should be consulted in the original note. E. B.

1859. *Photolysis of Dibasic Acids.* **Volmar.** (Comptes Rendus, 180. pp. 1172–1173, April 14, 1925.)—The introduction into the molecule of a carboxylic acid of a second carboxyl group increases its sensibility towards light, the active wave-length increasing with the degree of proximity of the two carboxyl groups. Oxalic acid exhibits the maximum sensitiveness. The reciprocal influence of the two carboxyl groups soon vanishes as the carbon atom chain lengthens, and, from succinic acid onwards, each of the groups acts as if alone, *i.e.* photolysis is produced under the influence of rays of wave-length $0 \cdot 21\mu$, just as is the case with monobasic acids.

T. H. P.

1860. *Kinetics of Photochemical Processes in Dyes.* **A. Predwoditeleff** and **N. Netschajewa.** (Zeits. f. Physik, 32. 3. pp. 226–235, 1925.)—The results are given of spectrophotometric measurements of the initial velocity of bleaching of cyanine- and pinacyanol-collodion layers containing the colouring matters in various concentrations. This velocity exhibits periodic variation, alternately rising and falling as the proportion of dyestuff present is continuously increased. The collodion exerts a softening influence on the maxima and minima of the curve.

T. H. P.

1861. *History and Theory of the Latent* [*Photographic*] *Image.* **Lüppo-Cramer.** (Zeits. wiss. Phot. 23. pp. 122–132, April, 1925.)—Further discussion of the evolution of the theory of the latent image [see Abstract 832 (1925)]. T. H. P.

1862. *Blackening of Photographic Plates at Low Densities.* **E. A. Baker.** (Roy. Soc. Edinburgh, Proc. 45. 2. pp. 166–186, 1924–1925.)—Light from a pointolite lamp fed with a battery of cells falls on two lens and prism systems which are symmetrically arranged with regard to the lamp and the small area of plate under test. In front of the plate at different distances are pieces of ground glass to diffuse the light. Thus by stopping out one lens system and making an exposure followed by a similar exposure with both lens systems, two exposed areas are obtained for which the ratio of illumination is exactly 2 to 1. Colour screens and a copper sulphate cell are interposed as necessary. Densities of the developed plates are measured with a photoelectric densitometer and string electrometer. A discussion of the results obtained with several types of plates is given and a bibliography of work on the validity of the reciprocity law.

A. Wh.

1863. *Use of Commercial Plates in Research on the Latent Photographic Image.* **F. C. Toy.** (Phil. Mag. 49. pp. 1104–1112, June, 1925.)—This is a theoretical discussion of the subject, from which it is concluded that it is necessary to use single-layer plates for all accurate work on the relation between the energy required for the formation of the latent image and the frequency. Under such conditions there is as yet no evidence sufficiently definite to enable any other condition to be drawn than that, per quantum absorbed, all frequencies of ultra-violet light are equally efficient in making developable the silver halide grain. [See also Abstract 92 (1925).]

A. E. G.

1864. *Modern Views on the Sensitivity of Emulsions.* **T. S. Price.** (Phot. J. 65. pp. 298–311; Disc., 311, June, 1925.)—A general survey of the subject in which certain specific points which have been brought forward in recent years are dealt with in as connected a manner as possible, taking the photoelectric effect as the starting-point. A. E. G.

1865. *Latent Fog.* **Lüppo-Cramer.** (Zeits. wiss. Phot. 23. pp. 184–200, April, 1925.)—A general account of the subject, to which is appended a useful bibliography of the various investigations to which reference is here made. A. E. G.

1866. *Single-Spark Photography and its Application to Some Problems in Ballistics.* **P. P. Quayle.** (Nature, 115. pp. 765–770, May 16, 1925.)—Spark photography, in which the illumination is provided by an electric spark of such short duration that a moving object appears stationary, has many applications in the investigation of high-speed phenomena. The record obtained is not an image, no lens being used, but is simply the silhouette of objects between the light source and the photographic plate. Two distinct problems are presented in the photography of moving objects. One of these is the timing of the spark so that the desired epoch of the phenomenon under investigation may be photographed, and the other has to do with the duration of the spark. All the photographs described here are taken on plates not larger than 8 by 10 in. The spark duration determines the amount of blurring. If the blurring is not to extend over more than 1/16 in. for a projectile moving at a speed of 2700 ft. per sec., the time of exposure must not exceed 2/1,000,000 sec. In order to secure a properly timed spark of suitable character there must be available a means of generating electrical energy at very high voltage, apparatus for the regulation of the voltage, and, finally, a means of releasing the stored energy at the proper time. The manner in which these parts are associated is shown diagrammatically. A comparison is made with the methods used by E. Mach, L. Mach and C. V.

Boys. The acceleration of the projectiles after leaving the muzzle is discussed, as is also gas motion at the muzzle. Modification of sound waves is shown by photographing a 0·30-calibre projectile after passing through a soap-bubble filled with a mixture of hydrogen and air. A photograph of a tracer bullet taken approximately 35 ft. from the muzzle shows the almost complete absence of a base wave. There are also other interesting photographs. A. E. G.

1867. *Photo-elasticity.* **E. G. Coker.** (Frank. Inst., J. 199. pp. 289–331, March, 1925.)—An address dealing with the development of photo-elastic science in which particular attention is paid to the stress distribution in piston rings, in dove-tail joints, and the stress due to a pin or rivet in a plate. C. O. B.

1868. *Fluorescence and Wave-length.* **S. J. Wawiloff.** (Zeits. f. Physik, 32. 3. pp. 236–238, 1925.)—**S. Valentiner** and **M. Rössiger.** (*Ibid.*, pp. 239–240.)—Controversy as to the interpretation of Valentiner and Rössiger's results [Abstract 2494 (1924)]. A. D.

1869. *Resonance Fluorescence of the* 1849 Å. *Line of Mercury-Vapour.* **W. Rump.** (Zeits f. Physik, 31. 12. pp. 901–902, 1925.)—The optical excitation of the resonance line 1849 A., in addition to the previously known resonance line 2536·7 Å., can be made evident photographically if oxygen, which absorbs the first line, is excluded from the path of the light throughout. H. N. A.

1870. *Note on P. Jordan's Treatise, " The Theory of Quantum Radiation."* **A. Einstein.** (Zeits. f. Physik, 31. 10. pp. 784–785, 1925.)—It is shown that the hypotheses upon which Jordan bases his statistical theory of the mechanism of radiation transformation are incompatible with the existence of an absorption coefficient. H. H. Ho.

1871. *The Structure of Radiation.* **E. C. Stoner.** (Cambridge Phil. Soc., Proc. 22. pp. 577–594, March, 1925.)—It is shown that, assuming conservation of energy and momentum in individual transitions, radiation must be regarded as propagated by linearly directed " quants." Evidence is brought forward in favour of the view that these quants are spatially localised longitudinally as well as laterally. As these conclusions seem unavoidable, an attempt is made to see if there is any possibility of accounting for interference effects in terms of quants possessing periodic properties. The idea that a single quantum can produce interference effects is untenable. The conception of the phase of a quant is introduced, and it is supposed that atoms may absorb a quant in a given phase providing they are in a " state " corresponding to that phase. Considering radiation emanating from a point, it is shown that a tentative explanation of interference may be obtained if the quants have a constant phase at emission, and if they give atoms at any point an impulse towards the state corresponding to their phase at the point. Practically the whole nomenclature and method of the wave theory may be taken over and applied to the quant phase field surrounding an emitting source. Quants are characterised by a magnetic and electric vector, whose magnitudes and directions define the state of polarisation and the phase. Electron orbits may also be regarded as characterised by two vectors in terms of which it seems as if the " state " may be specified. W. C. S. P.

1872. *The Michelson Experiment.* **G. Valle.** (N. Cimento, 2. pp. 39–73, Jan.–Feb.–Mar., 1925.)—A revision of Righi's theory (1918–1921) and Villey's work [Abstract 1170 (1920)]. The result is that the displacement of bands is brought back to Michelson's original estimate. A. D.

1873. *Polarisation of Sodium Resonance Radiation in Magnetic Fields. Larmor Precession of Excited Atoms.* **A. Ellett.** (Optical Soc. America, J. and Rev. Sci. Inst. 10. pp. 427–437, April, 1925.)—The polarisation of D-line resonance radiation [see Abstracts 99 and 838 (1925)] with various orientations of the impressed magnetic field has been determined in experimental conditions such that the depolarising action of high vapour pressure is eliminated. The results obtained are not in quantitative agreement with any of the various theories which have been advanced to account for the behaviour of resonance radiation in magnetic field. It is shown that a magnetic field produces a rotation of the plane of polarisation in resonance radiation, and that this rotation is due to the Larmor precession of the excited atoms. The value of τ for the $2p_1$ state of sodium is calculated from the observed rotation and found to be $1 \cdot 35 \times 10^{-8}$ sec. The value of the polarisation decay constant in the equation $R = R_0 \cdot e^{-KH}$ may be calculated from the equation

$$K = a \frac{\Delta v}{\Delta v_n} \cdot \tfrac{1}{2} \cdot \frac{e}{m} \cdot \frac{1}{c} \cdot \tau$$

where $\frac{\Delta v}{\Delta v_n}$ gives the ratio of the separation of the Zeeman levels in the upper state to the classical value, and a is a constant. T. H. P.

1874. *Sommerfeld's Theory of Fine Structure from the Standpoint of General Relativity.* **M. S. Vallarta.** (J. Math. Phys., Mass. Inst. of Technology, 4. pp. 65–83, April, 1925.)—The relativistic conditioned-periodic orbits of Sommerfeld's theory are deduced from considerations of the general theory of relativity. Considerations of the respective magnitudes of electronic and nuclear masses and charges in the case of hydrogen and hydrogenic ions of the type He^+, Li^{++} indicate that in these cases the material field of the nucleus is almost Euclidean and almost static. [See Abstract 502 (1923).] J. S. G. T.

1875. *Relation between the Closing In of Electron-Groups in the Atom and the Structure of Complexes in the Spectrum.* **W. Pauli, Jr.** (Zeits. f. Physik, 31. 10. pp. 765–783, 1925.)—Conclusion based on some preceding work and on the Millikan-Landé representation of alkali-doublets by relativistic formulæ that in these doublets and their anomalous Zeeman-effect we have a duplex character, not explainable classically, of the properties of the light-electrons, without the closed-in noble-gas configuration of the atomic residue being concerned, either by way of a body-impulse or as the seat of magneto-mechanical anomaly of the atom. Taking this as a working hypothesis, the endeavour is made to extend it to atoms other than the alkaline. It is found that, contrary to the general belief, it is possible in the case of a strong magnetic field, where we may ignore the coupling forces between atomic residue and light-electron, to give both the partial systems properties, both as regards the number of their stationary states and the values of their quantum numbers and their magnetic energy, no other than those of the atomic residue or the light-electrons in alkali metals. This leads to a general classification of the electrons in an atom by the chief quantum number n and two subsidiary quantum numbers k_1 and k_2, to which the presence of an external field adds another quantum number m_1. This classification, along with Stoner's work, leads to a general formulisation for the phenomena. A. D.

1876. *On the Excitation of Spectral Lines by Electronic Impact. II.* **G. Hertz** and **J. C. S. de Visser.** (Zeits. f. Physik, 31. 7–8. pp. 470–474, 1925.)—An earlier publication [see Abstract 1457 (1924)] outlines the investigation, of which this paper is a continuation. By photometric measurement of the intensities of different neon lines in their dependence on the velocity of the impacting electrons, the excitation potentials of these lines are computed. Using the series term, the so-calculated value of the ionisation potential of neon is found to be in good agreement with that electrically measured. H. H. Ho.

1877. *Line-Intensities in Band-Spectra and the Correspondence Principle.* **R. H. Fowler.** (Phil. Mag. 49. pp. 1272–1288, June, 1925.)—A general summary of the correspondence principle and its applications is given, with special reference to band-spectra. It is shown that the intensities of the lines in a single band must be expected to obey summation rules similar to those first recognised by Ornstein, Burger and Dorgelo in atomic spectra. Precise formulæ for the relative intensities are given in terms of the weights for the lines of any band without a zero branch. With the help of particular molecular models, the theory can probably be extended so as to include bands with zero branches. The theory seems to be in agreement with the experimental data available. It promises to provide evidence as to the weights of the states of a rotating molecule, and thus to fill up a gap. A. D.

1878. *Broadening of Lines in Arc Spectra and the Stark-Effect.* **H. Lowery.** (Phil. Mag. 49. pp. 1176–1183, June, 1925.)—The results of Kimura and Nakamura on the broadening of lines with increased current density [see Abstract 101 (1925)] suggest comparison with the author's work on interrupted arcs [see Abstract 851 (1925)]. Tables are given of the results for copper, silver and gold, in which the nature of the broadening is compared with that observed by Kimura and Nakamura. The effects are similar in the two cases, and such as would be expected from observations on the Stark-effect. Nickel and iron do not exhibit the broadening, although many nickel lines show the Stark-effect. It is also pointed out that, in interpreting the broadening of lines obtained by Duffield in his experiments on the effect of pressure on arc spectra, it is necessary to take into account the effects due to the heavy currents he employed and the necessity for repeatedly striking the arc. F. S.

1879. *The Intensity of Multiple Lines and their Zeeman Components.* **R. de L. Kronig.** (Zeits. f. Physik, 31. 12. pp. 885–897, 1925.)—It is shown that it is possible, by defining more closely and in a reasonable manner the conditions which can be deduced from the correspondence principle, to determine uniquely the intensity relations in multiplets, without magnetic field, with weak and with strong fields. In the formulæ which are deduced the intensities are expressed in a symmetrical manner in terms of the quantum numbers of the initial and final conditions of the atom; a law of permanence is deduced, which states that the sum of the energies which correspond to the transferences from a definite state J_1, m_1 to all the states J_2, m_2, remains constant when the magnetic field increases. A number of examples are given, including three triplets (calcium, $1p - 2d$; strontium, $1d - 3f$; calcium, $3d - 3d'$) and a quintet (chromium $D - D'$). The tables give the observed and calculated intensities for all the lines of the combinations, and the agreement is satisfactory, particularly so in the case of the triplets. Another table gives the intensities of the possible triplet lines $p - d$, $R = 3/2$, for different initial and final values of K, J, m, m_K and m_R, distinguishing between perpendicular, σ, and parallel, π, polarisation. H. N. A.

1880. *Intensity Measurements in the Ultra-violet Portion of Spectra.* **H. B. Dorgelo.** (Zeits. f. Physik, 31. 11. pp. 827–835, 1925.)—A description of an extension of the method previously described [Abstracts 1390 (1923) and 1454 (1924)] for measuring relative intensities of spectral lines of small wave-length difference, the method being now made applicable to the ultra-violet. A stepped absorbing screen was constructed with the help of a quartz plate covered with various thicknesses of platinum by the volatalisation of a platinum wire. The quartz platinum absorber is preferred to a photographic one, the latter absorbing light below 2800 Å. With the help of the platinum screen it is now possible to measure intensity relationships of spectral lines which are close together within the region 7000–2200 Å. A method is described for measuring the absorption by the platinum screen for various wave-lengths of incident radiation. The intensity relationships of the components of the spark doublets of the first and second diffuse series for calcium were measured, the results being in agreement with the rules previously published.
W. V. M.

1881. *Intensities in Flame Spectra and Spectral Lines.* **F. Dannmeyer.** (Zeits. f. Physik, 31. 1–4. pp. 76–80, 1925.)—Measures of intensities of manifold spectral lines of mercury-vapour led the author to the formula $\frac{J}{\nu_m} = c \, . \, \frac{md}{2^m}$, in which c is a constant. This was confirmed by C. E. Bleeker and J. A. Bongers for rubidium and cæsium. The whole number intensity law of Dorgelo appears to be valid only for the manifold spectral lines which lie very near together. [See Abstracts 1454 (1924) and 122 (1925).] E. H. B.

1882. *The Intensities of Lines in Multiplets.* **H. N. Russell.** (Nature, 115. pp. 835–836, May 30, 1925.)—Formulæ for the relative intensities of the lines of multiplets have been derived from the theoretical quantum conditions imposed by the correspondence principle, and give results in close correspondence with all the available observational data. Landé's quantum numbers, R, K, J, are best adapted to the problem. Ordinary multiplets occur when $K_1 - K_2 = 1$ and $K > R$. "Rhomboid" groups occur when $K_1 - K_2 = 1$ and $K < R$. Symmetrical groups occur when $K_1 = K_2$. The equations for all three groups are derived by applying the principles of Sommerfeld and Heisenberg to Landé's vector-model, using the means of the values of J and K in the initial and final state. Similar formulæ for ordinary multiplets have been recently published by Ornstein and Burger [Abstract 1360 (1925)]. Tables are given showing the close agreement between the observed, or estimated, and the calculated values of the relative intensities for a number of triplets, quartets, quintets, sextets and septets. H. N. A.

1883. *The Mass-Spectra of Chemical Elements. Part VI. Accelerated Anode Rays.* **F. W. Aston.** (Phil. Mag. 49. pp. 1191–1201, June, 1925.)—The paper contains the results of further work on accelerated anode rays carried out during 1924 on elements of higher atomic numbers, and is the last of this series, as if more exact comparisons of known lines are required apparatus of higher resolving power is needed. The chief results with respect to these elements are given below—Indium: probably simple of mass No. 115. Strontium: almost entirely 88, with a lighter isotope 86 to the extent of 3 to 4 %. The strong line gives a mean value 87·8 and is an undoubted deviation from the whole number rule. Barium: almost entirely 138, with possible traces of 136 and 137. The chemical atomic weight is too low. Lanthanum: simple at 139. Praseodymium: simple at 141. Neodymium: certainly 142, 144, 146 and doubtful 145. Cerium: 140 and faint 142. Zinconium: 90, 92, 94 and doubtful 146. Cadmium: six isotopes, 110, 111, 112, 113, 114, 116. Tellurium: 126, 128, 130—unique in that all its mass numbers form members of isobaric pairs. Bismuth: simple 209. Heaviest yet investigated. Further experiments have been made on Silicon: shown to be chiefly 28 with faint 29 and 30. Iron: doubtful 54 confirmed. Lead: shown to be complex but not resolved.

A survey of the elements not yet analysed is made and the possibility of their analysis discussed. A complete list of all isotopes so far determined is given. W. V. M.

1884. *The Hydrogen Spectrum.* **E. Gehrcke** and **E. Lau.** (Ann. d. Physik, 76. 7. pp. 673–679, May, 1925. From the Reichsanstalt.)—Work of Abstract 906 (1923) and 847 (1924) continued. Between 3300 and 1950 Å. the spectrum of pure hydrogen is *free from lines* and presents only a continuum. The lines of Liveing and Dewar and of Watson were due to CO. Lines of Hg and of Si may also appear. Slow electrons, which produce the Balmer series very faintly or not at all, produce both the line spectrum and the continuum powerfully. The line spectrum and the continuum are compared; points in the latter have the same brightness-and-electron-velocity curve; lines in the former have not the same curves, and the voltage is greater. A. D.

1885. *The Balmer Series of Hydrogen.* **L. Janicki.** (Ann. d. Physik, 76. 6. pp. 561–566, April, 1925. From the Reichsanstalt.)—Shrum's observations [see Abstract 1460 (1924)] require correction to clear them from shrinkage effect and from physiological and photographic broadening effect. The Koch-Goos registering photometer gives for doublet-distances values smaller and more probable than those of Shrum. The most probable values, from Shrum's data, appear to be $\Delta\lambda = 0 \cdot 130$ Å. for H_α, $0 \cdot 076$ for H_β, and $0 \cdot 060$ for H_γ, with corresponding $\Delta\nu$'s $= 0 \cdot 302$, $0 \cdot 322$, $0 \cdot 318$, which support Gehrcke and Lau's value $\Delta\nu = 0 \cdot 296$, not the theoretical $\Delta\nu = 0 \cdot 365$. A. D.

1886. *The Secondary Spectrum of Hydrogen.* **J. W. Nicholson.** (Roy. Astron. Soc., M.N. 85. pp. 449–464, March, 1925.)—The two bands of Fulcher are numerically related and form a simple system. The lines of the secondary spectrum *not* showing a Zeeman-effect are of the form of widely separated bands analogous to those of Fulcher, and it is probable that the number of distinct bands is very small. It appears that the nuclei move during the emission of band-spectra, and probably also that the motion of these nuclei must be quantised like that of the electrons.

A. D.

1887. *Regularities in the Secondary Spectrum of Hydrogen.* **O. W. Richardson** and **T. Tanaka.** (Roy. Soc., Proc. 107. pp. 602–623, April 1, 1925.)—This paper is a continuation of the authors' endeavour to arrange the lines of this spectrum in series by starting from a study of the lines which are selectively changed in intensity in electron discharge in hydrogen at a low pressure as compared with discharges in a Geissler tube of the type which is most usual in spectroscopic observations. It is unlikely that all the sequences mentioned in this paper will prove to be genuine physical series, and, in fact, the greatest difficulty of this investigation arises from the fact that there is no absolute criterion as to the genuineness of a series. It follows that, until the whole spectrum has been classified into series, it is necessary to regard each suggested series as merely provisional in character and liable to extinction as further information about alternative arrangements develops. In the table given are set out the constants of the known arrangements of the lines in this spectrum, and in doing this the data is arranged in three groups. The first group contains those series which seem fairly certain, the second group those which are rather probable, whilst those in the third group are to be considered merely as possibilities. In forming these judgments the authors have taken into account the number of lines in a sequence, the numerical coherence of the wave-numbers, the coherence of the properties, the distribution of intensity among the lines in a sequence, and its reasonableness from the point of view of the resulting moments of inertia. The first column gives the series under consideration, the second the value of v_0, the third the second difference Δ_2F of the initial term number $F(m)$, and the fourth the second difference $\Delta_2 f$ of the final term number $f(m)$. Where there is not enough information to deduce these quantities they are replaced by the corresponding initial and final constants $Ca = h/8\pi^2 I_a$ and $Ce = h/8\pi I_e$, I_a and I_e being the initial and final moments of inertia. The values of Ca and Ce are given in the fifth and sixth columns and the difference $Cd = Ca - Ce$ in the seventh. The eighth column contains the corresponding difference $\Delta_2F - \Delta_2 f$ for the cases in which it has been determined.

The chief thing that emerges from the numbers in the table is that the values of Ca (or Δ_2F) and Ce (or $\Delta_2 f$) are spread fairly well over the whole range between the extreme values $\Delta_2F = 44\cdot27$ of 1P28Q201R and $Ca = 258\cdot26$ of 83R. [See also Abstract 848 (1925).] A. E. G.

1888. *A Band of Unusual Structure, probably due to a Highly Unstable Calcium Hydride Molecule.* **R. S. Mulliken.** (Phys. Rev. 25. pp. 509–522, April, 1925.)—In the spectrum of the calcium arc in hydrogen at low pressure (best 3–20 mm.) an isolated band occurs in association with the lines of neutral calcium. The wide spacing of the lines and the absence of appreciable isotopic effect practically assure its hydride origin. The simple structure indicates a diatomic molecule. Reproductions and measurements of the lines are given. The band appears to consist of a P and an R branch with a single missing line in the middle. The two branches do not form a single series. From the abnormally weak central lines the intensity of each branch rises to a maximum, then begins to fall slowly until the lines are cut off sharply at the tenth line in the R and the eleventh in the P branch. These two lines both show a perturbation of $-0\cdot60$ wave number units. Assuming that these last perturbed lines have a common initial state, the band is analysed in accordance with Kratzer's theory, applicable to molecules which have net electronic angular momentum in the plane of molecular rotation. The last line in each branch corresponds to $j' = 11$.

The emitting molecule is probably a compound of hydrogen with an excited (not ionised) calcium atom, which may be of an unstable H_2-like type analogous to the emitters of the Zn, Cd, Hg, Cu, Mg and other hydride bands. W. V. M.

1889. *Absorption of a Line of the Principal Series of Singly Ionised Atomic Mercury.* **L. A. Turner** and **K. T. Compton.** (Phys. Rev. 25. pp. 613–617, May, 1925.)—Light from an electrodeless discharge in Hg vapour was passed through a region of a low-voltage arc in Hg vapour containing a high concentration of positive ions. The 1942 spark line showed absorption; the 2225 and 2848 spark lines did not show absorption. A rough determination of the excitation potentials showed these to be much higher for the 2225 and 2848 lines than for the 1942 line. These experiments verify J. A. Carroll's conclusion that the 1942 line is a member of the principal series, and that the other two are members of subordinate series of Hg. AUTHORS.

1890. *Absorption Spectrum of Atmospheric Oxygen in the Extreme Ultra-Violet.* **E. Schmidt.** (Zeits. f. Physik, 31. 7–8. pp. 475–487, 1925.)—The origin of oxygen bands in the Hg spectrum in the region 1840–2000 Å. is investigated. Earlier work, of which a full account is given, indicated three possibilities: (1) emission bands for the light source; (2) fluorescence bands in the air; and (3) absorption bands in the air. An experimental arrangement of a quartz spectrograph is described which can be filled with different gases and permits of tests to 1840 Å. without disturbance from atmospheric oxygen. By different methods it is proved that the bands are not due to fluorescence, but are perceived on the background of a continuous spectrum. Pure O_2 produces a wider and more intense absorption than when mixed with CO_2 or N_2. Pure CO_2 is transparent for this region 1840–2000 Å. The shading-off of the bands for long waves is interpreted by an absorption process in which the molecular state considered has a greater moment of inertia than the normal state. In agreement with Steubing, it is shown that the carrier of the band is the normal molecule O_2, and not O_3, which is produced by the ultra-violet radiation. R. S. R.

1891. *Determination of the Terms of the Lanthanum Spectrum.* **S. Goudsmit.** (K. Akad. Amsterdam, Proc. 28. 1. pp. 23–31, 1925.)—The paper consists almost entirely of tables of lines and their combinations, and should be consulted for details. W. V. M.

1892. *Luminescence of Solidified Gases at Liquid Helium Temperatures.* **L. Vegard, H. K. Onnes** and **W. H. Keesom.** (Comptes Rendus, 180, pp. 1084–1087, April 6, 1925.)—Deals with the spectra of light emitted when solidified nitrogen and mixtures of nitrogen and neon are bombarded with high-speed kathode-rays. The spectrum of *pure nitrogen* has essentially the same structure and position as at the temperature of liquid hydrogen. The N_1 band does not diminish with reduction of temperature, and the N_2 band is strong but divided into two components ($\lambda = 5236$ and 5222 Å.). Each consists of a regular series of bands which are large and diffuse at higher temperatures and which become concentrated into two fine lines at lower temperatures. Three or four feeble lines [$\lambda = 5914$, 5952, 6399 and 6417 (?)], probably corresponding with some in the auroral spectrum, were detected. For *mixtures of nitrogen and argon* the wave-length of the principal maximum is a function of the proportion of nitrogen, due partly to a specific action of the argon and partly to dilution of the nitrogen. At the temperature of liquid hydrogen the two influences are of the same order of magnitude. For *mixtures of nitrogen and neon* similar results are obtained, but the specific influence of neon is very small. The relation of the results to the interpretation of the auroral spectrum is discussed. [See Abstract 66 (1925).]

W. H. Ge.

1893. *The Arc Spectra of Silver and Copper.* **A. G. Shenstone.** (Phil. Mag. 49. pp. 951–962, May, 1925.)—In the arc spectrum, even when low voltage is employed, a certain number of spark lines may be present. In order to get rid of these the vapour is bombarded with low-velocity electrons by means of the three-electrode arrangement, with hot filament and accelerating grid, of Foote, Meggers and Mohler, and the emission of lines is due to the unionised atom only. Using copper or silver, it is not difficult to obtain the "single-line" spectrum by using a sufficiently low voltage. Nine or ten volts was used to obtain the complete arc spectrum of silver, and it was shown that there is little doubt that the accepted energy levels of the silver atom are correct. A number of lines were observed in the copper spectrum by this method, and a copper absorption spectrum was obtained. Tables of the above lines are given. The lines are due to transitions from levels $2p_2 = 31{,}772 \cdot 8$, $2p_1 = 31{,}524 \cdot 4$, $np_a = 22{,}194 \cdot 0$, $np_b = 21{,}364 \cdot 3$, np_c, np_d, np_e, np_f, np_g, np_h, Q, M, etc., to $1s = 62{,}308$, $md_1 = 51{,}105 \cdot 5$, and $md_2 = 49{,}062 \cdot 6$. Tables are given showing these combinations together with the observed lines; no series is evident in these lines. A number of lines observed are not explained, the nature of many of the terms found is not decided, and further investigations are necessary.

H. N. A.

1894. *The Electrical Excitation of the Iodine Band-Spectrum and Iodine Line-Spectrum.* **G. Carlo** and **O. Oldenberg.** (Zeits. f. Physik, 31. 12. pp. 914–919, 1925.)—The five band-spectra of iodine belong entirely to the neutral molecule, and hence new band-spectra were sought under conditions in which the formation of I_2^+ seemed easily possible. Only a narrow, weak group of bands at 2700 Å. was found. Hence a small stability for the ion J_2^+ or its excited state is surmised, as, for example, occurs for the ion N_2^+. A splitting up of the diffuse iodine bands observed by McLennan was found during electrical excitation in narrow capillaries.

The diffuse bands at 3460 appears to be split up into a series of bands when electrically excited as for fluorescence with high pressures of foreign gases. The line-spectrum of iodine was measured in an uninvestigated region. W. V. M.

1895. *Contribution to Knowledge of the Oxygen and Sulphur Spectra.* **E. Bungartz.** (Ann. d. Physik, 76. 7. pp. 709–728, May, 1925.)—With a few exceptions all the lines of the compound spectra of the elements oxygen, sulphur and selenium can be arranged in series. The most completely investigated is, however, oxygen, for which, in the triplet and doublet systems, a first and second diffuse series have been observed, as well as the principal series. Hopfields has come to the conclusion that the terms *m*S, *m*P and *n*D of the doublet system of oxygen form in reality a triplet system, this appearance of triplets being in accordance with Sommerfeld's "alternation" rule. The latter is supported by Landé's conclusion from measurements of Zeeman-effects that a quintet system also exists. In order to investigate the structure further it was thought advisable to make observations on the analogous sulphur spectrum, in which the separations should be greater and hence more accurately measured. A long account of experimental procedure is given. A comparison of the lines 7772 for oxygen and 7696 for sulphur shows that the doublet separation for sulphur is five times that for oxygen, and a series of results agreeing with this is given. Terms $2p_2$ and $2p_3$ for sulphur were calculated. A series of lines was measured having a complicated structure, and the possibility of arranging them in the series spectrum is discussed. W. V. M.

1896. *The Band-Spectrum of Mercury.* **E. Hulthén.** (Zeits. f. Physik, 32. 1. pp. 32–55, 1925.)—The band-spectrum of mercury has been investigated from the theoretical and experimental points of view, and the author has drawn up fairly complete tables of the results of measurements made hitherto. It is thought from the conditions under which they are emitted that a hydride of mercury is responsible for the bands, the spectra consisting of two systems corresponding to the same final state. The short-wave system shows perturbations which may be referred to a partial frequency of the molecule. A complete table of lines between 4550 and 3100 is given, the spectral terms being calculated empirically. W. V. M.

1897. *The Continuous Spectra of the Halogens.* **W. Steubing.** (Zeits. f. Physik, 32. 3. pp. 159–162, 1925.)—The theory of the so-called "continuous" spectra of gases is very incomplete, and the idea put forward by J. Franck [Abstract 850 (1924)] of an "electron affinity spectrum" appears from recent observations [Oldenberg, Abstract 2498 (1925)] to be untenable. Some of the spectroscopic evidence is considered, and it is concluded that the appearance of the spectra is not connected with the molecule, but that this spectra may be near a band-spectrum. It cannot be excited by small energy changes (*e.g.* as occur in light absorption), but that it appears under conditions of strong dissociation and ionisation, yet standing in no simple relation to the line spectrum. The conclusion is reached that the free electrons must play an important part in its production. The position and sharpness of single spectral lines indicate sharply defined energy states, and hence inversely it follows that alterations of the atomic structures by such electronic transitions as occur between no well-defined states cannot give rise to strictly monochromatic emission, and will be determined by dissociation and probability considerations. Such considerations lead to a theory of the continuous spectra of gases in terms of the breaking up and recombination of the outer electronic rings of the atoms and molecules. These processes will evidently not produce monochromatic radiation, because each electron of the broken ring will possess no well-defined energy. Also the total radiation from such "unorientated" electrons must lie between given limits, having, for instance, a long wave limit which is determined by the interior of the atom, *i.e.* the force which it exerts on the outer shell. Hence the long wave limit to the "continuous" spectra under consideration, the position of this limit varying from element to element, yet being fairly sharply defined. W. V. M.

1898. *The Fundamental Term of the Neon Spectrum.* **S. Goudsmit.** (Zeits. f. Physik, 32. 2. pp. 111–112, 1925.)—The previous measurements of the critical potentials of neon by Hertz [Abstract 601 (1924)] have shown that the fundamental term must be an optically undiscovered one at approximately 174,000 cm.$^{-1}$, while the results due to Dorgelo make it probable that this term is a p term or group of terms. Meissner's investigations [see Abstract 1188 (1925)] also lead to similar conclusions. According to Landé, the s_2 and s_4 terms have quantum numbers $J = 1\frac{1}{2}$, while s_3 and s_5 have numbers $J = \frac{1}{2}$ and $J = 2\frac{1}{2}$ respectively. Again, the fundamental term is not combined with the latter terms, and hence has a quantum number $J = \frac{1}{2}$, since this will, according to the selection principle, allow combination with s_2 and s_4, but not s_3 and s_5. It is also thought probable that this p term is simple. The value $J = \frac{1}{2}$ is in agreement generally with spectroscopic and magnetic evidence. Hence $K = 2$ and $J = \frac{1}{2}$. W. V. M.

1899. *Emission Band-Spectra of Aromatic Compounds. Part I. Their Connection with Infra-red Absorption Bands and a Classification.* **J. K. Marsh.** (Phil. Mag. 49. pp. 971–980, May, 1925.)—The paper is largely a commentary on previous work by the author and collaborators. The spectra studied are shown to be capable of classification into (1) a benzene type characterised by bands at frequency intervals of 102 and 15·7 waves/mm.; (2) a benzene aliphatic-derivative type with band intervals of 40 or 80 in the ultra-violet; (3) the "blue bands"—a spectrum produced by Tesla discharge through a number of substances of which benzaldehyde is an outstanding example; (4) a condensed nuclei type. Anthracene and derivatives show three or four characteristic bands near 4000 Å.U. In the infra-red, bands of absolute frequency equal to ultra-violet frequency differences are often well marked and characteristic. W. V. M.

1900. *Emission Band-Spectra of Aromatic Compounds. Part II. Their Origin.* **J. K. Marsh.** (Phil. Mag. 49. pp. 1206–1216, June, 1925.)—A continuation of the work of the preceding Abstract. It is concluded from a consideration of a parallel between the infra-red band intervals of ethylene and the ultra-violet band intervals of benzene, naphthalene and anthracene that the bands exhibited by these substances originate in a C = C band. Similarly the band intervals of type (2) of the preceding paper are shown to originate in a CH band. Benzene spectra are accounted for as a combination of C = C and CH vibrations. Probably the "blue band" type originates from a carbon-oxygen band. A view of the benzene molecule is taken, accounting for the fact that the bands originating from the two carbon atoms of the C = C bands show evidence of their being in a state of mutual rotation, while the CH groups appear to have a rotation frequency of which their vibration frequency is an exact multiple. W. V. M.

1901. *Radiating Atoms in Magnetic Fields.* **P. Zeeman.** (Frank. Inst., J. 199. pp. 585–596, May, 1925.)—This address gives an historical *résumé* of work on the Zeeman effect, including mention of recent work on some chromium lines, Ornstein's investigations of intensity, and Hale's work on sunspots. F. S.

1902. *The Series Spectra of the Stripped Atoms of Phosphorus* (P_V), *Sulphur* (S_{VI}), *and Chlorine* (Cl_{VII}). **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 25. pp. 295–305, March, 1925.)—Spectra of stripped atoms, sodium to chlorine. Grating spectrograms of order three to eight have been obtained of the hot-spark spectra of these elements, which have yielded more accurate values for the $(3p_2 - 3p_1)$, $(3s - 3p_2)$ and $(3p_1 - 3d)$ terms of Al_{III}, Si_{IV}, P_V and S_{VI}, and have enabled the identification and determination within about 5 frequency units (1) of 18 series lines of P_V and thence of the 14 most important term values ($3s$ to $6f''$); (2) of 11 series lines of S_{VI}, and 10 corresponding term values ($3s$ to $5f'$); and (3) of the first doublet of the principal series of Cl_{VII} at 800·70 and 813·00 Å. The position of this doublet was first predicted by using the method developed in a previous paper [Abstract 135 (1925)], based on observed regularities in these spectra. Further evidence is presented for the fact that both the regular aud irregular doublet laws of X-ray spectra hold also throughout the field of optics. A curve of $\sqrt{\nu/R}$ for the stripped atom levels as a function of atomic number gives approximately straight lines (Moseley's law), those for the $3s$, $3p$ and $3d$ terms and for the $4s$, $4p$, $4d$ and $4f$ terms being approximately parallel (irregular doublet law). The doublet separations $d_1 d_2$, however, do not fit well into the relativity doublet law, the ratio of observed to theoretical values decreasing from about 0·8 for Si_{VI} to less than 0·2 for Si_{IV}, while Al_{III} and Mg_{II} are anomalous, d_1 having a greater frequency than d_2. The general similarity of the spectra of all these elements is strikingly shown in spectrograms on which appear the "D" doublet of Na and the corresponding "D" doublets of the stripped atoms of Mg, Al, Si, P, S, and Cl in the second, third, fourth, fifth, sixth and seventh orders respectively, all near 5600 Å., that for Na being farthest from the mean position. The frequencies of all the known terms found for the stripped atoms of Na to S are collected in a table. Ionisation potentials of P_V and S_{VI}, computed from the $3s$ levels of P_V and Si_{VI}, come out 64·7 and 87·6 volts. W. V. M.

1903. *The Series Spectra of Two-Valence-Electron Atoms of Phosphorus* (P_{IV}), *Sulphur* (S_V), *and Chlorine* (Cl_{VI}). **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 25. pp. 591–599, May, 1925.)—In a previous paper [Abstract 135 (1925)] the regular and irregular X-ray doublet laws were used to predict the spectra of stripped atoms—that is, atoms having only one valence electron. The method has now been applied to the spectra of two-electron atoms, since, although these spectra consist of triplets or singlets instead of doublets, the same laws apply to them. In this way 23 lines of P_{IV} have been identified, 17 lines of S_V and 6 lines of Cl_{VI}. With the help of the Ritz equation, 12 term values of P_{IV} and 8 of S_V were also determined. In a table are collected all known term values for two-electron atoms of Mg, Al, Si, P and S. Spectral lines which give parallel curves on a Moseley diagram $\sqrt{\nu/R}$ (plotted as a function of atomic number), and which therefore follow this law, are produced by jumps between orbits of the same total quantum number, but with different screening constants. AUTHORS.

1904. *Seeman's Spectrograph and Measurement of Normal X-Rays.* **A. P. Weber.** (Zeits. wiss. Phot. 23. pp. 149–183, April, 1925.)—The results here obtained show that the Seeman spectrograph method is completely suitable and is useful for precision measurements. Used in conjunction with other methods, it makes possible the setting up of a normal system of X-ray wave-lengths. [See also Abstract 297 (1922).] A. E. G.

1905. *Semi-optical Lines in the X-Ray Spectrum.* **E. Bäcklin, M. Siegbahn** and **R. Thoraeus.** (Phil. Mag. 49. pp. 513–517, Feb., and **L. de Broglie** and **A. Dauvillier,** pp. 752–753, April, 1925.)—Defining the true X-ray spectral lines as transitions between energy levels normally occupied by electrons, and the optical spectral lines as belonging to transitions from a free outer orbit to a vacant space in the outermost energy shell, we have "semi-optical" lines which are emitted by an electron starting from a free level of the atom, or, say, a true X-ray line belonging to a metastable form of the elements where the outermost electron is moving in another orbit than that of the normal atom. These are illustrated by the line called $K\beta_1$, which does not appear below Na(11), and in Na(11) and Mg(12) is not a continuation of the $K\beta_1$ of higher elements. The same peculiarity is presented by the $K\beta_2$ line at K(19) and, with less simplicity, in analogous cases higher up the series. Conclusions are developed as to the electronic structure. De Broglie and Dauvillier claim priority of publication, 1922–1924. A. D.

1906. *The Compton-Effect with Hard X-Rays.* **D. L. Webster** and **P. A. Ross.** (Nat. Acad. Sci., Proc. 11. pp. 224–227, April, 1925.)—Describes a preliminary survey on the Compton-effect with hard rays, which shows by experiments with glass and graphite shifts in the tungsten lines, agreeing pretty closely with those predicted by the Compton theory. In the case of silver, the α-line of the fluorescent rays was very strong; elsewhere the rays were too weak to detect, except possibly at or near the unshifted tungsten α-position. H. N. A.

1907. *The Reflection of X-Rays by Alkali Halide Crystals.* **Alice H. Armstrong, W. Duane** and **R. J. Havighurst.** (Nat. Acad. Sci., Proc. 11. pp. 218–221, April, 1925.) Describes marks on photographic films produced by the reflection of X-rays from certain potassium iodide crystals, which indicate the presence of very small crystals, displaced from their normal positions, but with their axes parallel to that of the main crystal. Experiments show that, when reasonably good crystals are employed which have no marked structure of this kind, the spectrometer curves show no abnormal peaks corresponding to reflection of the characteristic iodine radiation. The curves are normal and what would be expected, taking into account the characteristic absorption of the X-rays by the iodine in passing through the crystals. Similar results were obtained with cæsium iodide. It is probable that many of the reflections of characteristic lines previously observed may have been due to the above peculiar structure. The observed critical voltages at which these reflections appeared corresponded with wave-lengths near those of the K-series lines of iodine, and the crystal is very transparent for these wave-lengths. H. N. A.

1908. *Note on the Diffraction of X-Rays by a Wedge-shaped Slit.* **I. I. Rabinov.** (Nat. Acad. Sci., Proc. 11. pp. 222–224, April, 1925.)—Using a **V**-shaped slit, with faces parallel to the X-ray beam, the author has obtained fine fringes at the narrow end of the slit for the $K\alpha$ line of molybdenum. A crystal of calcite was placed before a parallel adjustable platinum iridium slit, in such a position as to reflect through it the $K\alpha_1$ line only; the X-rays were then diffracted by the **V**-shaped slit, and the diffraction pattern was photographed. It has not, however, been possible to measure the wave-length of the $K\alpha_1$ molybdenum rays by this means, on account of the difficulty in determining the width of the slit in the position where diffraction takes place. The observed diffraction seems to be of the right order, using the accepted value of the wave-length 0·7 Å. H. N. A.

1909. *On the Use of Monochromatic X-Rays in the Production of Laue Diagrams and on the Structure of Mother-of-Pearl.* **J. H. Shaxby.** (Phil. Mag. 49. pp. 1201–1206, June, 1925.)—[See also Abstract 1118 (1925).] W. V. M.

1910. *Modern X-Ray Tube Development.* **W. D. Coolidge.** (Frank. Inst., J. 199. pp. 619–648, May, 1925.)—This paper deals largely with the technical production of electron X-ray tubes. Technical points are dealt with, such as the shielding of the filament, control of the size of focal spot, protection from inverse current, target construction, tearing of the target face, effect of size of bulb, effect of operation on vacuum, secondary electron emission, etc. Such points are chiefly of interest to those engaged in X-ray tube manufacture and technology.

Of more general interest are the results of using thorium and metallic uranium for the target. In general the results appear to indicate irregularities due to impurities, which should not, however, be insurmountable, and such tubes can now be considered as practicable. A description of the recent "baby Coolidge" tube and apparatus follows, which is essentially the same as Abstract 877 (1925). B. J. L.

1911. *A Simple X-Ray Apparatus for the Investigation of Crystals.* **H. Lange.** (Ann. d. Physik, 76. 5. pp. 455–475, April, 1925.)—A metal Coolidge tube was constructed, with mercury joints for the kathode and anti-kathode and a specially constructed aluminium window, so that all the parts were quickly renewable. Seemann and Bohlin's method for dealing with crystal powders was employed, a special camera having been designed which permitted a very accurate adjustment of slit, specimen and film; this gave an accuracy of 0·05 % in the lattice constants determined. The time necessary for an exposure was reduced greatly; 90 to 100 milliampere-minutes were necessary with 45 kilovolts.

The apparatus was tested on aluminium, using iron and copper K-radiation and tungsten L-radiation; the lattice constant was found to be 4·036 ± 0·002 Å. The advantages and disadvantages of the method as compared with that of Debye and Scherrer are discussed. [See Abstract 1763 (1925).] H. N. A.

RADIO-ACTIVITY.

1912. *Radio-activity.* **A. F. Kovarik** and **L. W. McKeehan.** (Nat. Research Council, Bull. 10. pp. 1–203, March, 1925.)—A monograph on radio-activity taking as a starting-point the state of our knowledge in 1916. The paper is divided into the following sections: (1) radio-active transformations; (2) α-rays; (3) β-rays; (4) γ-rays; (5) nuclear structure and radio-active processes; (6) radio-activity in geology and cosmology; (7) effects of radio-active radiations on matter. Numerous references are given. A. B. W.

1913. *Electrical Behaviour of Individual Radio-active Colloidal Particles of the Order of* 10^{-5} *cm.* **F. Ehrenhaft.** (Phil. Mag. 49. pp. 633–648, April, 1925.)—The author claims priority with regard to the method of determining the electric charge on individual particles, as used, for example, by Millikan in determining the value of "*e*," the electronic charge. Millikan's methods are criticised and reasons are given in support of the author's previous observations on sub-electrons (carrying a charge of a tenth or twentieth of "*e*"). Further experiments are now described in which the motion of a small colloidal spherical test body, made radio-active and of dimensions 10^{-5} cm., was observed in a constant electric field. The particles employed were selenium or mercury made radio-active by exposure to RaEm. A single particle was observed, its motion changing from one type to another with accompanying change of speed, giving the impression of a continuous change of electric charge. Non-radio-active test bodies were used as a check. The author considers these and similar experiments strong evidence in favour of the divisibility of the electron. A. B. W.

1914. *Determination of the Ratio of the Velocities of the Two Groups of X-Rays from the Active Deposit of Thorium.* **S. Rosenblum.** (Comptes Rendus, 180. pp. 1332–1334, May 4, 1925.)—Describes a new apparatus for the determination of the velocities by the magnetic deflection method, in which the distance between the magnet poles is greatly reduced by an ingenious device, which enables the two pole surfaces to be used as two of the walls of the evacuated space, in which the α-particles pass through two slits to the photographic plate from a metal wedge carrying the active deposit. In this way a very intense homogeneous field can be obtained, 15,000 to 18,000 gauss; and the ratio of the velocities was found to be 1·209. The cube root of the ratio between the ranges in air at ordinary pressure and temperature 15° C. of the particles from ThC, 8·62 cm., and ThC′, 4·78 cm., is 1·217, in good agreement with the velocity ratio. H. N. A.

1915. *Range of* α*-Particles from RaC.* **D. Pettersson.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 5–6. pp. 149–162, 1925.)—Observations on the range and relative number of long-range α-particles emitted from

RaC. The results are in general agreement with those previously obtained by Bates and Rogers [Abstract 1197 (1924)]. A. B. W.

1916. *β-Rays produced by Homogeneous X-Rays of Short Wave-Length.* **H. Ikeuti.** (Comptes Rendus, 180. pp. 1257–1259, April 27, 1925.)—A Wilson expansion apparatus is employed to photograph the β-ray tracks produced when X-rays from a Coolidge tube (excited from a coil giving a 40-cm. spark) pass through the expansion chamber. A large number of photographs have been examined with the following results: *Length of Tracks.*—The β-rays appear to be of two types, *viz.* high-velocity electrons due to the normal photoelectric effect and the low-velocity electrons described by Wilson as fish-tracks and sphere-tracks. The mean length of tracks obtained with X-rays of $\lambda = 0\cdot21$ Å.U. in air at 570 mm. pressure was 76 mm., corresponding to a value between 57 and 65 mm. at 18° C. and 760 mm. of mercury pressure. Whiddington's law indicates a value having an upper limit of 67 mm. The maximum length of the "fish" tracks for the same wave-length X-rays lay between 3·3 mm. and 3·7 mm. The paper concludes with a discussion of the theoretical bearing of the experimental results. A. B. W.

1917. *Characteristic γ-Spectra and their Photoelectric Effect.* **J. Thibaud.** (J. de Physique et le Radium, 6. pp. 82–98, March, 1925.)—The author has studied the spectra of γ-rays by utilising the secondary β-rays excited by the γ-rays in different substances, an improved magnetic deviation method being employed to analyse the secondary β-rays. The law of Einstein has been verified over a wide range of elements and for radiations of which the quantum approaches to 2×10^6 volts. The author concludes that it is possible to apply Einstein's law to measure very high frequencies, and has determined in this manner twenty-four monochromatic radiations in the spectra of the radio elements of the radium and thorium families. The results are considered in regard to theories of the origin of β-ray spectra and the mechanism of disintegration. [See also Abstracts 2987 (1924) and 1127 (1925).] A. B. W.

1918. *Quantity of Heat liberated in the Emission of γ-Rays in Radioactive Disintegration.* **J. Thibaud.** (Comptes Rendus, 180. pp. 1166–1169, April 14, 1925.)—The author calculates, on the basis of the quantum theory, the fraction of the total heat emitted by radium in equilibrium due to the γ-radiation. His analysis is as follows:—

α-rays and recoil	117·7 gr. cals./hour
β-rays primary	12·0 gr. cals./hour
γ-rays	7·2 gr. cals./hour
Total	136·9 gr. cals./hour

The β-ray emission is due solely to the products B and C; the heating effect of the β-rays in these substances is about double the effect of their γ-radiations. A. B. W.

HEAT.

1919. *The Thermal Expansion of some Alkali Metal Halides at Low Temperatures.* **F. A. Henglein.** (Zeits. phys. Chem. 115. pp. 91–120, Feb., 1925.)—This paper is part of an experimental investigation concerning the space relationships in crystals. The densities of NaCl, NaBr, NaI and KCl, KBr and KI have been determined first by the pyknometer method at 0° and − 79°, when the fused salts were found to possess a higher specific gravity than those crystallised from aqueous solution. Following this section, a gas volumenometer is described by means of which the densities of solid salts can be determined at all temperatures, and data are given for room-temperature, 0°, − 79° and − 184°. The expansion coefficients thus found were smaller with lowering temperature, but the ratio atomic heat/coefficient of expansion proved constant at all temperatures. The following regularities were established between the expansion coefficients and the chemical compositions of the salts: For the same kation the expansion coefficients increase with increasing atomic weight of the anion, whereas for the same anion they decrease with increasing atomic weight of the kation. The percentage expansion is approximately the same for all the above salts from absolute zero to room-temperature. By comparison of the molecular volumes at the room-temperature, the salts can be regarded as being in corresponding states. The paper is replete with apparatus details and data. H. H. Ho.

1920. *The Critical Temperature and the Dilatation of Liquids.* **N. de Kolossowsky.** (J. de Physique et le Radium, 6. pp. 99–104, March, 1925.)—The different formulæ proposed are at variance with one another or are limited in their application to particular liquids. That of Mendelejeff, in which the coefficient of dilatation is made variable, conforms to the facts in very different substances. It is also intimately connected with the theory of corresponding states. From it we reach a formula $K(BT_K - 273) = 1$, where K is Mendelejeff's coefficient at the reduced temperature $m = 0 \cdot 6$, T_K is the critical temperature, and B is a numerical coefficient which depends exclusively on the reduced temperature chosen. A. D.

1921. *The Specific Heat of Incandescent Tungsten by an Improved Method.* **L. I. Bockstahler.** (Phys. Rev. 25. pp. 677–685, May, 1925.)—A modification of a method suggested by Smith and Bigler is used [see Abstract 1649 (1922)], in which the uncertain cooling effects at the ends of the filament are eliminated. A tungsten filament surrounded by a cylindrical anode is heated to incandescence in vacuum by a 60-cycle current. By means of a double-strip oscillograph continuous photographic records of the heating current and of the thermionic current variations are obtained. Since saturation potentials are applied to the anode at all times, the small changes in thermionic current are taken as proportional to the temperature changes. Knowing the magnitude of the temperature changes and the mean power dissipated in the filament, its specific heat is calculated from the theoretical relations deduced by Corbino. The temperature of the filament is determined with a pyrometer for a steady current giving the same thermionic emission as the alternating current under consideration. This temperature is taken to correspond to the mean thermionic current as indicated by a d.c. ammeter. The specific heat of tungsten found by this method is 0·045 for temperatures between 2375° and 2475° K, in good agreement with previous determinations. A method of making tungsten seals in pyrex is described.

AUTHOR.

1922. *The Heating and Cooling of Bodies of Simple Geometrical Form.* **H. Gröber.** (Zeits. Vereines deutsch. Ing. 69. pp. 705–711, May 23, 1925.)—In this paper the author points out that although the heating and cooling of spheres, cylinders and plates have been worked out mathematically in the form of infinite series, the results have not been given in a form suitable to the use of technical and engineering students, who have not time or training for long mathematical calculations. This drawback the author attempts to overcome by taking the expressions for the time variation of temperature θ and writing them as functions of $\phi t/R^2$ and hR for the sphere and cylinder and of $hx_1\phi t/x^2$ for the plate. These quantities are termed "characteristic numbers," and are pure numbers not involving dimensions. A further simplification is effected by considering the temperature to be measured, not in degreees, but as a fraction of the initial temperature. A number of tables and graphs are given from which the surface temperature and the heat loss can be read off in several useful cases. The work of Williamson and Adams on "Temperature Distribution in Solids during Heating and Cooling" [Abstract 1517 (1919)] is referred to and some abstracts given. T. B.

1923. *Saturation Pressures of Mercury up to* 2000 *kg./cm.*^{2} **F. Bernhardt.** (Phys. Zeits. 26. pp. 265–275, April 2, 1925.)—The highest vapour-pressure of mercury previously measured is recorded by Cailletet, Colardeau and Rivière [Abstract 1814 (1900)], who investigated up to 162 atmos. at 880° C. The author has now repeated these measurements and extended their range, while he has also brought the results into line with Bender's data [see Abstract 1433 (1915)], which include density determinations of liquid and gaseous mercury up to 1400°. Three different experimental installations are described in detail with illustrations and results up to 170 kg./cm.^{2} The final section is devoted to a full account of experiments in a closed bomb up to 2000 kg./cm.^{2} This was a **U**-tube device of quartz-glass filled with mercury whose temperature was recorded by a thermo-element, and the manipulative details of which are very minutely described. The observations, when graphically depicted, afford a somewhat steeper curve than the one by Cailletet. The Hertz formula for the saturation-pressure curve $lnp = k_1 - k_2 ln\mathrm{T} - k_3/\mathrm{T}$, employing the constants of Smith and Menzies, is in good accord with the data up to 1000° C., and still shows fair agreement up to 110°. The same holds good for Knudsen's calculated constants. A discussion of the critical constants of mercury concludes the paper. H. H. Ho.

1924. *Joule's First Measurements of "J."* **W. W. H. Gee.** (Engineer, 139. pp. 426–428, April 17, 1925.)—Gives hitherto unpublished details obtained from Joule's laboratory books of his initial and very difficult experiments connected with his first attempt at the measurement of the mechanical equivalent of heat. W. H. Ge.

1925. *Mechanics of the Quantum Relation in the Case of Black (Heat) Radiation.* **S. Ray.** (Zeits. f. Physik, 32. 6. pp. 473–475, 1925.)—The constancy of the ratio of wave-length to amplitude in the case of thermal radiation, as in the case of luminous radiation [see Abstracts 965 and 967 (1922)], is established from thermodynamic considerations. J. S. G. T.

1926. *The Theory of the Equilibrium of Radiation.* **L. Strum.** (Zeits. f. Physik, 31. 11. pp. 866–868, 1925.)—Gives a new method of deriving the expression for the probability of an elementary process of radiation transformation, a quantum with frequency ν transformed into another quantum with frequency ν_1 in time dt, and gives a new form for this expression. Mathematical. H. N. A.

1927. *Radiation from Non-Luminous Flames.* **R. T. Haslam, W. G. Lovell** and **R. D. Hunneman.** (Indust. and Engin. Chem. 17. pp. 272–277, March, 1925.)—The object of the experiments described was (1) to investigate the absolute amount of radiation from flames of different gases, and the effect of varied aeration and preheating; and (2) to study the effect of flame size and depth of flame upon the radiation per unit area. For (1) use was made of a small flame of known composition, with solely primary aeration, the radiation being measured by means of a thermopile. A modified Méker burner was used giving a flame of about 0·5 cm. high, and was placed at a distance of 60–70 cms. from the thermopile in an enclosure maintained at constant temperature. The thermopile-galvanometer system was calibrated against a standard lamp. For (2) use was made of a long horizontal pipe into which measured amounts of air and gas were fed so as to produce a continuous flame along the pipe. The ratio of primary air to gas was maintained constant during the runs, but the total aeration was unknown, since the flames burned freely in the atmosphere. The gases used were methane, carbon monoxide and illuminating gas. The results show that the radiation drops off if the amount of primary aeration is either increased or decreased beyond that required for complete combustion. When the theoretical amount of air is used the radiation from one volume of methane was found to be 4·45 times that of one volume of CO_2. This does not agree with the theory of von Helmholtz, which gives 1·85. Heating the primary air has the effect of decreasing the radiation. The authors suggest that this may be due either to precombustion or to a shift of the chemical equilibrium conditions in the flame with increasing temperature. There is no apparent simple relationship between the amount of radiation and the composition of the gas or the products of combustion. The radiation per unit area for a flame is found to increase with the depth of flame, according to an exponential law $R = K(1 - e^{-kx})$, as used by Callendar. The authors suggest that radiation from a flame is a matter intimately connected with the chemical reactions which are taking place there rather than with temperature, and that in the spectroscopic study of flame radiation there exists a powerful tool for the investigation of complex chemical reactions. W. C. S. P.

SOUND.

1928. *Critical Velocity of Flow Past Objects of Aerofoil Section.* **E. G. Richardson.** (Phys. Soc., Proc. 37. pp. 178–182; Disc., 182–183, April, 1925.)—By observations of the "Æolian Tones" of vibrators of aerofoil section [see Abstract 1854 (1924)], critical values for flow past an object of aerofoil section have been obtained of a fluid incident at various angles. The minimum value of VL/*v* for unsteady flow is found to fall from 60 at 0° incidence to 45 at 20°, and then more rapidly. AUTHOR.

1929. *Binaural Audition.* **E. Meyer.** (Elekt. Zeits. 46. pp. 805–807, May 28, 1925. Teleg. u. Fernsprech. Techn. 14. pp. 121–125, May, 1925.)—A semi-popular review of the work done on this subject in the war and other apparatus to which it has given rise. [See Abstracts 444 (1907) and 899 (1921).] E. H. B.

1930. *Sensibility of Circular Diaphragms for the Reception of Sounds in Water.* **J. H. Powell.** (Phys. Soc., Proc. 37. pp. 84–95; Disc., 95–96, Feb., 1925.)—An investigation is described of the sensitivity of circular diaphragms as receivers of submarine sounds. The diaphragms, machined from solid ingots of metal, were mounted with one face immersed in water, and to the other face was attached a microphonic or electromagnetic detector. The diaphragms were all designed to have a frequency of 850 ∼/sec. under these conditions. The response of the diaphragms to sounds of a single definite frequency was measured, and resonance curves were obtained from which the magnitude of the damping due to the detector was determined. A value was also obtained for the concentration of energy in the restricted volume of the experimental tank, and an investigation was made of the effect of the proximity of sound reflectors and of the vibrating diaphragm of the source of sound. It was shown that when corrections were made for these effects the values for the resonance amplitude and for the persistence of vibration were consistent with those determined mathematically by H. Lamb [Abstract 285 (1921)] for diaphragms under ideal conditions. The investigation was extended to cover complex sounds or "noises" of no definite pitch, and the results were again consistent with theoretical anticipations. A. B. W.

1931. *Notes on Theory of the Thermo-Microphone.* **A. v. Hippel.** (Zeits. f. Physik, 31. 9. p. 716, 1925.)—A reply to criticisms by J. Friese and E. Waetzmann of previous paper [Abstract 910 (1925)]. G. A. S.

1932. *Investigation of the Thermo-Microphone.* **A. v. Hippel.** (Ann. d. Physik, 76. 6. pp. 590–618, April, 1925.)—The theory of the thermo-microphone developed in a previous paper [Abstract 910 (1925)] is here tested experimentally and the practicability of the apparatus investigated. The convection stream theory is established by varying current, thickness of wire, frequency, amplitude, direction of the convection flow, rapidity of the flow, in turn, measurements of the final sound being made by suitable electrical apparatus. A similar comprehensive test, using the human ear as arbiter, gives results in agreement. The efficacy of a conductor of negative resistance characteristic as a thermo-microphone material is tested, and it is shown that the working of the so-called kathodophone cannot be due to a normal ionic pressure effect. The effectiveness of a home-made instrument proves the usefulness of the thermo-microphone. G. A. S.

1933. *Additions to the Theory of the Helmholtz Resonator.* **A. T. Jones.** (Phys. Rev. 25. pp. 696–704, May, 1925.)

1934. *The Frequency of a Helmholtz Resonator with a Hyperboloidal Mouth.* **A. T. Jones.** (Phys. Rev. 25. pp. 705–710, May, 1925.)—It is shown theoretically that if the circular hole in a resonator is replaced by a hyperboloidal mouth which reduces the flux in the ratio $(1 - \mu_1)$, the freqnency is reduced in the ratio $[(1 - \mu_1)/(1 + \mu_1)]^{1/4}$. The ratio of the greatest velocity—which occurs close to the wall at the narrowest section—to the velocity at the middle of the section is $1/\mu_1$. The lowering of pitch is given for six hyperboloidal mouths. Eight experimental determinations of frequency were made with two brass hyperboloids. The greatest difference between the observed and the calculated pitches was 0·3 of a half-step. This agreement indicates that the viscosity of the air, which is neglected in the theory, has little effect on the frequency. [See also preceding Abstract.] AUTHOR.

1935. *Acoustical Test for Hydrogen.* **E. Hurwitz.** (Zeits. techn. Physik, 6. 3. pp. 113–116, 1925.)—The known phenomena of different sound speeds in the various gases appears hitherto to have found practical application only to detection of fire-damp in mines badly ventilated. The method is here relatively ineffective, but for hydrogen reaches its utmost sensitiveness. The industrial application of this method for the regular checking of hydrogen installations and the apparatus designed for this purpose are here described. E. H. B.

1936. *Natural Notes of Tapered Rods.* **W. Hort.** (Zeits. techn. Physik, 6. 5. pp. 181–185, 1925. Paper read before the Internat. Congress for Techn. Mechanics, Delft, 1924.)—The calculation of the natural notes of tapered rods is approximately found by the application of Rayleigh's principle for the determination of the increase in pitch of a slightly altered system, and is reduced to a simple formula. G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1937. *Affine Asymmetrical Theory of the Electromagnetic Field and Atomic Radiation.* **H. Eyraud.** (Comptes Rendus, 180. pp. 1245–1248, April 27, 1925.)—The author has shown in an earlier paper [Abstract 1010 (1925)] that the magnitudes determining the states of an electromagnetic and gravitational field find their natural geometrical interpretation in an affinely connected space applicable projectively and conformly upon a Riemann space. In the present paper he shows, in the first place by tensor analysis, that this field theory is not incompatible with quantum postulates. G. W. DE T.

1938. *The Structure of Light.* **J. J. Thomson.** (Engineering, 119. pp. 602–604, May 15, 1925. Fison Memorial Lecture.)—The lecture was mainly a presentation of his recent paper [see Abstract 177 (1925)] without the mathematics. G. W. DE T.

1939. *The Continuity of Vector Power in an Alternating Electric and Magnetic Field.* **H. Nukiyama.** (Inst. El. Eng. Japan, J. Selected Papers, No. 2 [34 pp.], Oct., 1924. In English.)—This is a mathematical paper, unsuitable for detailed abstract, in which a treatment of an alternating electric and magnetic current field is undertaken by means of vector analysis; the vector quantities considered are harmonic functions of time. Special attention is given to the expression of the vector power and of its distribution throughout the field. The laws of continuity of the field and Maxwell's fundamental electromagnetic equations are expressed in symbolic form. The phenomena of dielectric and magnetic hysteresis in a revolving elliptic electric and magnetic field are discussed under the assumption of elliptic hysteresis loops, the expression of hysteresis loss and average stored potential and kinetic energy in such a field being given in operational form. The vector field of electric intensity and magnetic force is decomposed into curl, divergence and impressed field, the result being applied to the decomposition of vector power; the fundamental principle of continuity of vector power in an alternating electromagnetic field is thereby expressed either in differential or in integral form. The results are applied to the analysis of the technical problem of the expression of vector power for interlinked linear magnetic and electric circuits. B. H.

1940. *The Electric Currents in a Network.* **P. Franklin.** (J. Math. Phys., Mass. Inst. of Technology, 4. pp. 97–102, April, 1925.)—This article is not suited to detailed abstracting, and should be consulted in the original. It gives an alternative proof of Kirchoff's theorem. A. E. C.

DISCHARGE AND OSCILLATIONS.

1941. *Low-Voltage Arcs in Sodium and Potassium Vapours.* **F. H. Newman.** (Phil. Mag. 49. pp. 1057–1064, May, 1925.)—From experiments carried out with low-voltage arcs produced in special quartz bulbs it was found that the potentials necessary to strike and maintain arcs in sodium and potassium vapours depend primarily upon the vapour density and the temperature of the kathode, the potentials decreasing as the vapour density and the kathode temperature both increase. The voltage required to maintain such arcs is always less than the striking voltage, but the difference becomes smaller as the vapour density is lowered. Arcs, struck and maintained with potentials less than the ionisation potential of the vapour, are obtained with intensely hot kathodes, the ionisation in such cases arising probably from the absorption of radiation emitted from atoms already excited but not ionised. Such ionisation by "photo-impact" results in complete ionisation of the vapour atoms by electrons, none of which have a velocity greater than that corresponding to the resonance potential. The spectra of such low-voltage arcs have been investigated, and the results will be given in a subsequent paper. [See Abstract 1134 (1917).] A. W.

1942. *Gas Kathodes and their Radiation in the Striated Glow-light.* **E. Goldstein.** (Zeits. f. Physik, 32. 3. pp. 190–196, 1925.)—The author's opinion, expressed in 1876, that the strata of the positive glow-light are repetitions of the kathode light has now become generally accepted. Later Gehrcke [see Abstract 162 (1905)] showed the possibility of these layers being gas kathodes. It is now shown that the emission zones of the rays of which the strata of the positive glow-light consist are shell-like gas kathodes, convex towards the kathode, which can be rendered visible under suitable conditions. Very complete experimental details, with illustrations, are included. H. H. Ho.

1943. *Influence of Incident Foreign Kathode-Rays on the Kathode Fall of a Glow Discharge.* **A. Wehnelt** and **A. Jachan.** (Zeits. f. Physik, 31. 9. pp. 666–680, 1925.)—The influence of incident kathode rays on the dark kathode space is investigated. It is found that when kathode rays fall on the kathode disk of a cylindrical glass tube a decrease takes place in the kathode fall, which fall can be made ultimately nil. The dark space then vanishes completely. This effect occurs when the electron current generated by the kathode rays impinging on the kathode is equal to or greater than the current in the principal tube. It is found that there is no difference in the action whether the kathode rays fall at an oblique angle or at right angles to the kathode. The electrons rebounding at the kathode metal flow partly through the kathode to earth and partly are reflected at the surface. Both kinds of rays contribute to the decrease of the kathode fall. The decrease of potential observed with the incident kathode rays is similarly produced by means of Lenard rays. A. E. G.

1944. *Actinic Action of the Electric Spark Discharge.* **F. Berger.** (Zeits. techn. Physik, 6. 5. pp. 188–192, 1925.)—A method is described which makes it possible to obtain a quantitative ratio between the actinic action of the spark discharge between electrodes of different metals. Experiments are carried out with copper, brass, mercury and magnesium, and the ratios for these found to be 1 : 1, 1 : 1, 4 : 1, 6. A. E. G.

1945. *Variation of the "Extinction" Voltages of Certain Types of Low-tension Discharge Tubes under Different Conditions.* **J. Taylor**

and **W. Stephenson.** (Phil. Mag. 49. pp. 1081–1103, June, 1925.)—The paper contains a description and theoretical discussion of results on the measurements of the extinction or lower critical voltages of "Osglim" lamps and certain types of air discharge-tubes, when a charged condenser is connected across the electrodes, and a "flash" takes place. The method used for measurement is that previously described, and is such that the lower critical voltage is determined under the actual conditions of a "flash" when a condenser of known magnitude, charged to a known potential, is connected across the tube. The object of the present paper is to examine in a more or less general theoretical manner such condenser discharges, and to put forward some results obtained in those of the "Osglim" lamp and air discharge-tubes. It is shown that the experimental results are in general agreement with those predicted from theoretical considerations. The least voltage required for production of a "flash" for capacity C across the discharge-tube electrodes is given by $V_c' = V_c + q_1/C$, where V_s is the normal sparking or upper critical potential, and q_1 is the quantity of electricity used up in establishing the glow. Certain confirming experimental results for the "Osglim" lamp are given. A. E. G.

1946. *The Relative Mobility of Initial Positive Ions in Gas Mixtures at Low Pressures.* **H. B. Wahlin.** (Phys. Rev. 25. pp. 630–635, May, 1925.)—The relative mobilities of the initial positive ions in gas mixtures at pressures of 30 to 60 mm. have been determined for mixtures of C_2H_5Cl and H_2, N_2 and H_2, and N_2 and C_2H_5Cl, using the Franck-Rutherford alternating potential method and ions produced by a-rays of polonium. High-frequency potential generated by a Hartley oscillator was used so as to insure that the age of the ions was only a fraction of a second. In each case two types of ions were detected, for which the ratio of the mobilities came out equal to the inverse ratio of the square root of the molecular weights. These ratios were found to be independent of the relative amounts of the gases present, although the absolute values of the mobilities changed. This would seem to indicate that the initial mobility at low pressures is determined chiefly by the mass of the ion rather than by its dimensions. The fact that aged ions have lower mobilities indicates that they are clusters. [See also Abstract 637 (1925).] AUTHOR.

1947. *The Absorption Coefficient for Slow Electrons in Gases.* **R. B. Brode.** (Phys. Rev. 25. pp. 636–644, May, 1925.)—Electrons from a heated filament were accelerated through a slit and deflected magnetically around a circular path into a Faraday cylinder connected to a galvanometer. From the plots of the logarithm of the ratio of the galvanometer current G to the total electron current M from the filament, as a function of the pressure, the absorption coefficients were determined for various accelerating voltages from 2 to 360. For a given voltage, the absorption coefficient was found to be independent of the current M and also of the pressure (at about 10^{-2} mm.). The results of Mayer and Ramsauer were checked for argon and helium. In argon the coefficient reaches a sharp maximum at about 12 volts, the value for 2 volts being only one-fifth of the maximum value. In helium there is a maximum at 4 volts. Methane gave a curve similar to these, with a maximum at about 7·5 volts, which is in agreement with the results of Akesson. The curves for nitrogen and carbon monoxide are nearly identical, both having a maximum at about 18 volts and a minimum at about 9 volts. The curve for hydrogen shows no maximum, the coefficient increasing steadily down to 2 volts. AUTHOR.

1948. *Electron Emission from Oxide-coated Filaments.* **L. R. Koller.** (Phys. Rev. 25. pp. 671–676, May, 1925.)—(1) Effect of various gases. Platinum iridium filaments were coated with oxides of Ba and Sr by repeatedly dipping in a solution of the nitrates and burning in a CO_2 atmosphere. Under good vacuum conditions the emission corresponds to the equation $I = aT^2e^{-b/T}$, where $a = 0{\cdot}00107$ amp./cm.^{2} and $b = 12{,}100$ deg. for the filaments studied. The presence of oxygen in small amounts (10^{-3} mm.) decreases the emission ten to a thousand-fold, depending on the temperature, while argon, hydrogen, CO and CO_2 cause a great increase. These results indicate that the emission is due not to the oxides, but to a film of metal. (2) Positive ion bombardment also increases the emission, probably by reducing some of the oxide. (3) Flashing at 1600° K. for 1 to 5 min. de-activates the filament, but heating at lower temperatures (900° K.) restores the activity. (4) Distribution of initial velocities was found to follow Maxwell's law, but the average energy came nearly 30 % higher than that corresponding to the temperature of the filament. AUTHOR.

1949. *On the Precise Measurement of the Critical Potentials of Gases.* **E. G. Dymond.** (Roy. Soc., Proc. 107. pp. 291–309, Feb. 2, 1925.)—In order to make the inelastic impact method of determining the critical potential of a gas more definite, a valve circuit is used, arranged to give the differential of the current voltage characteristic. To make the velocity of the electron stream definite only about 1 mm. length of the filament strip was coated, requiring about 0·1 volt drop along this length. Helium carefully purified at a pressure of 1·1 mm. was used for the test on account of the data already obtained for this gas. Two rotating commutators with brass wire brushes were used, one to add a small alternating potential at 25 ∼ to the steady potential applied to the grid, while the other rectified the resulting variations in the plate current, at the same time turning the steady portion of this current into alternating current. The 1000-ohm plate galvanometer, sensitivity 2×10^{-10} amps. per mm. of scale, by reason of its long period of one minute, neglected this a.c. Comparative results are given of the normal and the differential methods. For the latter a retarding potential between plate and grid of 0·4 volt was used, while 0·1 volt alternating was added to the potentials between the filament and grid; potentials varied in turn between 20 and 44 volts. The differentiated method curves are discussed to determine the critical potential, and corrections determined by the double impact method are applied. The distance between the two break points, repeated to 0·15 volt, was 20·9 volts, while the usual figure is 20·45 volts. The experimental result, if the allowance discussed is made, becomes 19·6 volts, and this is compared with the critical potential of 19·77 volts from the spectroscopic evidence of Lyman. W. C. S. P

1950. *Primary and Secondary Products of Ionisation in Hydrogen.* **H. D. Smyth.** (Phys. Rev. 25. pp. 452–468, April, 1925.)—Previous results [Abstract 1263 (1924)] have been extended, using a new but similar apparatus in which ions produced by accelerated electrons are accelerated through a slit into a chamber where a magnetic field bends them round a semi-circle whose radius depends on the speed, field and ratio of mass to charge. Those going into a Faraday cylinder are measured by means of an electrometer. The conclusion that ions produced at 16 volts are diatomic was confirmed, but no evidence of simultaneous ionisation and dissociation, which was previously thought to occur for voltages above 20·2, was obtained. Atomic ions H^+ are, however, readily produced by secondary dissociation of molecular ions H_2^+ even when the maximum electron energy is just above 16 volts. Triatomic ions H_3^+ also appear in large numbers for any voltage above 16. Mathematical theory of the dependence of the relative numbers of H_2^+ and H^+ ions on pressure gives curves in general agreement with experiment. The paper concludes with a discussion of the processes involved in ionisation followed by dissociation. A. W.

1951. *Single and Double Ionisation of Argon by Electron Impacts.* **H. A. Barton.** (Phys. Rev. 25. pp. 469–483, April, 1925.)—The magnetic deflection method described by Smyth [see preceding Abstract] has been applied to a study of the ionisation of argon, and the minimum potentials for the production of singly and doubly charged ions have been separately observed. Assuming that for A^+ to be 15·2 volts [Abstracts 601 and 1796 (1924)], the correction for the apparatus was determined, and the corrected minimum potential for the production of A^{++} ions was found to be 45·3 ± 1·5 volts. No A^{+++} or A_2^+ ions were observed. Spectroscopic evidence has shown that the blue spectrum is excited by impacts of 34 volts, and it has been assumed that doubly charged ions are produced at this potential. Four ways of reconciling the author's results with the spectroscopic evidence are discussed. A. W.

1952. *Total Ionisation produced in Air by Electrons of Various Energies.* **Gladys A. Anslow.** (Phys. Rev. 25. pp. 484–500, April, 1925.)—Using a method similar to that of Hughes and Klein [Abstract 1496 (1924)] results were obtained for voltages ranging up to 2225 volts. From ionisation-pressure curves the range of electrons of various energies was determined, and was found to obey the fourth-power velocity law. The total ionisation curve begins at 17 volts and rises with minor peaks at 127, 250, 375 and 494 volts of 1·83, 2·70, 4·10 and 5·05 ions per electron, to 43·2 ions per electron at 1000 volts; then the increase is apparently linear to 55 ions per electron at 2225 volts. These results tend to confirm Bohr's theory of ionisation as corrected by Fowler. The total ionisation peaks at 250, 375 and 494 volts are interpreted as the ionisation potentials of the L-electrons of argon and the K-electrons of nitrogen and oxygen respectively. The 987 volt electrons are probably those which give the "sphere" tracks in C. T. R. Wilson's photographs; their range at atmospheric pressure is 0·04 mm. A. W.

1953. *Ionisation of Potassium Vapour under the Action of Visible Light.* **A. Arnulf.** (Comptes Rendus, 180. pp. 1259–1262, April 27, 1925.)—Describes a series of observations of the ionisation currents in an evacuated bulb containing a heated tungsten filament and a disc at a certain potential above that of the filament. The variations of current are observed when this bulb is illuminated by visible light, the bulb being filled with potassium vapour distilled from a side chamber attached to the bulb. The effects observed could not be attributed to a layer of solid potassium condensed on the plate. A. B. W.

1954. *Ionisation of Salt Vapours.* **V. Kondratjeff.** (Zeits. f. Physik, 32. 7. pp. 535–541, 1925.)—The experiments form a continuation of similar work on other halides [Abstract 1541 (1924)], but improvements have been introduced to avoid difficulties arising from condensation of the vapours on metallic parts of the apparatus. The vapours of $ZnCl_2$ and NaI have been investigated. It is shown for the former that decomposition of the molecule into the ions $ZnCl^+$ and Cl^- occurs at 12 ± 1 volt. An interpretation has also been given of the other maxima which occur in the ionisation of this vapour. At the electrolytic decomposition of NaI vapour the following ions were detected: Na^+, NaI^+, and I^-. As the results of the tests are not yet sufficiently definite, further experiments are being carried out to establish the processes resulting when dissociation occurs by electronic bombardment. R. S. R.

1955. *A Space Charge Effect.* **E. W. B. Gill.** (Phil. Mag. 49. pp. 993–1005, May, 1925.)—In a triode valve with both grid and plate at a positive potential with respect to the filament, but with the grid potential higher than the plate potential, it is found that the proportion of total current passing from filament to plate is constant. This phenomenon is discussed in detail and a generating arrangement indicated independent of magnetic or capacity coupling between plate and grid. The effect is discussed from both theoretical and experimental aspects.

B. J. L.

1956. *Space Charge and Thermionic Currents.* **W. S. Kimball.** (Phil. Mag. 49. pp. 695–708, April, 1925.)—The theory of the effect of space charge on thermionic currents in high vacuum has been discussed by many authors, but no attempt seems to have been made to analyse the potential function into its two component parts, *viz.* the potential that would be present if the space charge were removed to infinity and the space potential itself. The present paper is a study of the relations between these two parts. Attention is restricted to the case of currents where the kathode velocity of the electrons is zero. The case of parallel plane electrodes is considered in detail, and here a special study of the boundary values of the charge density and electron velocity at the anode shows how the equation for the current may be derived without integrating the differential equation of the potential function. For cylindrical electrodes conditions are established which the exact equation for the current must satisfy, and the approximate expression given by Langmuir is shown to fulfil these. G. A. S.

1957. *Passage of Kathode Rays through Matter.* **B. F. J. Schonland.** (Roy. Soc., Proc. 108. pp. 187–210, May 1, 1925.)—Apparatus is described for the production of kathode rays of velocities up to 0·55 of that of light (100,000 volts) in quantities easily measurable on a galvanometer. These rays have been used to extend the author's measurements [see Abstract 131 (1924)] of kathode-ray absorption to the β-ray region, and a detailed study has been made of the fractions transmitted, absorbed and scattered back under various conditions. The difference in the variation of apparent absorption with velocity for different elements is shown to depend on the fact that this is not a true absorption, since it includes the effect of scattering back of the rays on the side of incidence. The existence of a range for these rays has been further established by three independent methods of measurement. The values found for the ranges at various velocities in aluminium are in close agreement with those calculated on Bohr's theory of absorption, which has now been tested from $\beta = 0\cdot 20$ to $\beta = 0\cdot 90$ with rays of penetrating power varying in the ratio of 1 to 5000.

It is concluded that kathode-ray absorption is due to the gradual loss of energy of the moving particles by collisions with the electrons in matter, such collisions taking place more freely than the usual conceptions of atomic structure allow. A. B. W.

1958. *Longitudinal Asymmetry in the Direction of Ejection of Photoelectrons.* **O. K. DeFoe.** (Phil. Mag. 49. pp. 817–824, May, 1925.)—The object of the experiments described was to determine the ratio of the forward to backward photoelectric current excited in a given substance by X-radiation of a definite frequency. The directions of ejection of photoelectrons were determined by taking stereoscopic photographs, by the Wilson cloud method, of the ionisation tracks of the photoelectrons. The forward and backward tracks were counted and their ratio determined. Homogeneous Kα radiation from molybdenum was employed, the photoelectrons being ejected from air in the Wilson expansion chamber. The average ratio of forward and backward tracks was found to be 2·89. The theoretical bearing of this result is discussed. A. B. W.

1959. *Quantum Theory on Asymmetries in the Direction of Ejection of Photoelectrons.* **F. W. Bubb.** (Phil. Mag. 49. pp. 824–838, May, 1925.)—The author propounds a quantum theory in explanation of the two asymmetries, longitudinal and lateral, observed in the direction of ejection of electrons produced by high-frequency radiation. Experiments of Beatty and Bragg are quoted as lending general support to the theory, and the experiments of Cooksey and DeFoe give results in close numerical agreement with the predictions of the theory. A. B. W.

1960. *Secondary Oscillations in an Electronic Tube Oscillator.* **O. M. Corbino** and **E. Persico.** (Accad. Lincei, Atti, 1. pp. 358–363, April 4, 1925.)—The authors have observed with the Braun tube the form of the plate current in a valve oscillator in which the oscillating circuit was inserted in the plate circuit. The Braun tube was so excited as to give Lissajous' figures, the abscissæ of which were given by the sinusoidal current in the self branch of the oscillating circuit and the ordinates by the non-sinusoidal current through the plate. It was found that a coil inserted in the plate circuit outside the oscillating circuit gave rise, during the half-period in which the potential plate reached its maximum, to oscillations of a frequency depending on the values of the additional coil and of the capacity between the grid coil and the coil of the oscillating circuit. Some oscillograms illustrate the article. E. B.

1961. *The Diagram of the Plate Current in Triodes.* **O. M. Corbino** and **E. Persico.** (Accad. Lincei, Atti, 1. pp. 412–417, April 19, 1925.)—

In a former article [see preceding Abstract] the authors have shown how to use the Braun tube for obtaining the diagram of the oscillating current in the plate of a triode. In the present note the author shows how to utilise these diagrams in order to calculate the power furnished by the triode. These diagrams can be divided into two classes: one of elliptical shape, the other in the shape of half an ellipse. In the first case the energy is furnished by the plate battery during the entire oscillation, in the second case only by shocks, once per period. E. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1962. *Crystal Rectification of Alternating Currents.* **A. C. James.** (Phil. Mag. 49. pp. 681–695, April, 1925.)—Evidence is here adduced in support of an electrolytic theory of unilateral conductivity. Galena has a transition point at 160° C., there being at this temperature a rise of conductivity which is increased by the addition of silver sulphide. When the point at the contact is negative, the passage of a direct current through galena is accompanied by the electrolytic formation of metallic threads; when the point is positive, a high-resistance film is electrolytically formed. Unilateral conductivity and rectification are closely connected with these electrolytic processes. The thread formation is increased by the addition of silver sulphide and decreased by the addition of stannous sulphide. Unilateral conductivity and rectification can be explained from a consideration of the structure of crystals, taking account of the fact that in solid electrolytes the current is carried entirely by one set of ions, the other set forming a fixed framework. In rectification the metal ions oscillate to and fro through fixed channels of sulphur ions, giving metallic and non-metallic contact alternately. The variation of the rectifying properties at different points is due to the fact that the metal ions can move without collision in some planes of the crystal, but not in others. Experimental determinations of the values of the ratio of the conductivities in opposite senses for different directions in the crystal are in complete accordance with this theory, which elucidates hitherto unexplained phenomena connected with crystal rectification. G. A. S.

1963. *The Electrical Conductivity of Heated Gas.* **R. N. Ghosh.** (Zeits. f. Physik, 32. 2. pp. 113–118, 1925.)—The conductivity of a gas depends on its ionisation potential. The present paper attempts to extend the Drude-Thompson theory of conductivity to make it applicable to an ionised mass of gas. Stellar material is found to be about one hundred times as conducting as copper. This low value is due to the roughness of the method of finding the number of atoms per c.c. G. A. S.

1964. *Dielectric Constants.* **G. E. Bell** and **F. Y. Poynton.** (Phil. Mag. 49. pp. 1065–1072, May, 1925.)—Application of valve-maintained oscillatory circuits to the measurement of the dielectric constant of castor oil, olive oil, and linseed oil, with special reference to its variation with temperature. A linear relation is found to hold in each case. Methods discussed. A. D.

1965. *Thomson-Effect in Copper, Iron and Carbon Steels.* **J. Young.** (Phys. Soc., Proc. 37. pp. 145–156; Disc., 156–157, April, 1925.)—Using

Nettleton's method, the Thomson-effect is measured throughout the range 40° C. to 300° C. in pure copper, Armco iron, and three carbon steels containing respectively 0·15, 0·60 and 1·1 % of carbon. Except in the case of the copper, the value of the Thomson-effect is found to be different according as the current flows up or down the temperature gradient. This is considered to be due to asymmetry in the specimens, induced by inhomogeneity. Photomicrographical examination confirms this impression, the asymmetry being connected with the direction in which the wire is drawn. G. A. S.

1966. *The Permanent Polarisation of Solid Dielectrics.* **S. Mikola.** (Zeits. f. Physik. 32. 6. pp. 476–488, 1925. Abstract.)—The permanent polarisation of a solid dielectric comprises two parts, *viz.* an internal polarisation due to displacement of free ions of the medium by the exciting field, and directed in the opposite direction to the field, and an external polarisation, due to external ions, directed in the same direction as the field. Internal polarisation increases gradually with time, and is proportional to the field-strength. External polarisation is observed at the surfaces of both ionised and non-ionised media. Different kinds of external polarisation are produced under certain definite conditions, *viz.* (*a*) when the electric field is sufficiently strong to cause both positive and negative ions to be present, (*b*) when surface ionisation is produced in the presence of moisture, (*c*) when ionisation by impact is effected by a sufficiently strong field, and (*d*) when the dielectric makes intimate contact with two parallel conductors, one of which is charged. Unilateral, unipolar dielectric plates and non-uniformly polarised plates become in time completely self-polarised. External polarisation diminishes, in the case of ionised media, by a process of conduction, whilst in the case of non-ionised media its disappearance is attributable to ionic diffusion.

J. S. G. T.

1967. *The Photoelectric Primary Current in NaCl Crystals.* **B. Gudden** and **R. Pohl.** (Zeits. f. Physik, 31. 9. pp. 651–665, 1925.)—The rock-salt employed was coloured yellow by X-rays [Röntgen, Abstract 712 (1921)] and was illuminated by short wave-length light from a mercury arc light passed through a copper oxide ammonia filter, so as to allow the lines 405 and 436 $m\mu$ to pass; the p.d. between the electrodes was 800 volts, and curves are given showing the instantaneous values of the current when the light was allowed to pass, when it was cut off, and when, after a certain interval, infra-red radiations were allowed to fall on the crystal, which was placed in an electric oven. With small illuminations with blue light the current rose at once to a certain value at 33° C., and dropped slightly linearly when the illumination was continued. When the illumination was cut off the current dropped at once to a small amount, which remained constant during the short pause; infra-red radiation then caused the current to jump up to more than five times its original value, but it dropped off, at first very rapidly and afterwards slowly, towards a constant value, which was that due to the infra-red radiation acting photoelectrically. At 125° C. the crystal no longer insulated before illumination; the current rose to much higher values when it was illuminated (nearly four times the cold value); it dropped quickly to a small value during the dark interval, and only rose a little, with a rapid after-drop, when infra-red radiation was sent through. The difference is due to the effects of thermal movements in causing the return of electrons to the excited centres, which send out an electron when they absorb blue light. The effects are very similar to those previously observed in crystals with high refractive index, and it is shown that they are closely related to the phosphorescence of the substance, the so-called negative component of the primary current corresponding to the excitation of the phosphorescent centres, and the positive component (returning electrons) to the emission of phosphorescent light. H. N. A.

1968. *Quantum Equivalent by Photoelectric Conduction in Rock-salt Crystals.* **Z. Gyulai.** (Zeits. f. Physik, 32. 2. pp. 103–110, 1925.)—The spectral distribution of the photoelectric conductivity in rock-salt, under the incidence of X-rays, taken with respect to absorbed light energy, has been determined. The gain increases throughout the whole absorption band proportionally with the wave-length. Thereby is the quantised nature of this light absorption proved. The paper is illustrated with tables and graphs. E. H. B.

1969. *Absolute Frequency of Electric Vibrations: Wavemeter.* **E. Glebe** and **E. Alberti.** (Zeits. techn. Physik, 6. 3. pp. 92–103, and 6. 4. pp. 135–145, 1925.) From the Reichsanstalt.)—The construction of a wavemeter or frequency measurer developed in the Reichanstalt for the absolute measurement of electric waves and the method of using it are here described. It deals with the frequency region from 1600 to 300,000 per sec. (wave-lengths from 190 to 1 km.) with an accuracy of (0·1 to 0·2) %. E. H. B.

1970. *Comparison of Frequencies by Kathode-Ray Tube.* **D. W. Dye.** (Phys. Soc., Proc. 37. pp. 158–166; Disc., 166–168, April, 1925.)—Arrangements for the superposition of a telephonic and a radio-frequency displacement of the light spot of a kathode-ray tube are described. A circular or elliptical trace at a telephonic frequency can serve as a time axis. On this axis can be placed radial, circular, and straight-line displacements at low radio or high audio frequencies. Examples are given of the stationary patterns so produced. By using a long, narrow, elliptical time displacement and a straight line high-frequency displacement in a direction at right angles to the major axis wave-forms can be delineated. In the *Discussion* **E. V. Appleton** refers to a special type of triode oscillator, for which a patent application has been filed, giving a linear and uni-directional time base. G. A. S.

1971. *Oscillograph Study of the Aluminium Valve.* **F. H. Newman.** (Phil. Mag. 49. pp. 1029–1033, May, 1925.)—The author has made a study, using the Duddell oscillograph, of the rectifying properties and interrupter action of the aluminium valve (*i.e.* an anode of Al in electrolytic solution of dilute sulphuric acid). Contrary to previous statements, it was found that the temperature of the electrolyte did not affect the rectifying properties of the valve. Impurities present in the electrolyte have a detrimental effect on the rectifying properties, and sodium chloride appears to be very prejudicial in this respect. Self-induction in the circuit causes incomplete rectification. The small time-interval necessary for the anode formation indicates that diffusion plays little or no part in the phenomenon. A. B. W.

ALTERNATING CURRENTS AND MAGNETISM.

1972. *The Field of Force near the Neutral Circle between Two Equal Coaxial Coils.* **R. M. Wilmotte.** (Roy. Soc., Proc. 107. pp. 716–724, April 1, 1925.)—When a current is passed through two equal coaxial coils so that the components of the magnetic fields parallel to the axis add, there is a circle midway between the two coils, at the circumference of which the magnetic field is zero. If a turn of wire be placed to coincide with this circle, any small variation in its radius will affect the value of the mutual induction only to the second order of small quantities. Use is made of this in the Campbell standard of mutual inductance and in F. E. Smith's apparatus for measuring the absolute value of the ohm by the Lorenz method. The author investigates the conditions necessary to make the second order terms in the evaluation of the mutual inductance small, and the magnitudes of the changes in the mutual inductance due to displacements of the secondary in various directions. He concludes that the ratio of the diameter of the secondary to that of the primary should be made as large as is consistent with maintaining an accurately measurable size for the primary and keeping the instrument reasonably compact; also that a square section is most suitable for the secondary. In the case of the Lorenz apparatus, if the rotating disks on which the brushes are applied were bevelled at an angle of 45° to the axis any inaccuracy in the location of the brushes would affect the result only to the third order of small quantities. G. A. S.

1973. *Some Experiments on Induction Coils.* **J. A. Crowther.** (Brit. J. of Radiology, 21. pp. 49–58; Disc., 64–66, April, 1925.)—Describes experiments upon a 16-in. "intensified" coil and an oil-immersed coil. The apparatus used for investigation has been previously described. [Abstract 1814 (1924).] Oscillograph curves are given, and amongst the results the following are the salient features: On open circuit the intensified coil acted as an oscillation transformer, the periodicity of the oscillation not being dependent upon the primary capacity but upon the distributed capacity of the secondary. The damping was shown to be very little dependent upon the primary resistance. The efficiency is seriously altered if one end of the secondary is earthed, as sometimes occurs in practice. With the oil-immersed coil it is shown that the voltage of the secondary is obtained at the expense of efficiency, and that the only oscillatory system is the primary circuit, it being supposed that the distributed capacity of the secondary is too small to permit its taking up any appreciable amount of energy, and the damping of the secondary is very high. Upon an X-ray tube circuit the introduction of the tube resistance tends to render the discharge aperiodic in the intensified coil. In the oil-immersed coil oscillations were perceptible, and as the voltage rapidly decays, only a narrow band of X-radiation is produced. The variation of self-inductance of the primary circuit renders the production of any complete mathematical theory of the coil remote. B. J. L.

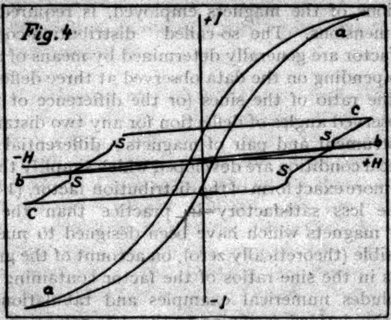
1974. *On the Effect of Capacity on the Induction Coil.* **J. A. Crowther and R. J. Stephenson.** (Brit. J. of Radiology, 21. pp. 59–64; Disc., 64–66, April, 1925.)—On the theory of the induction coil due to Rayleigh, with a sufficiently rapid interruption of the primary circuit, the action of the primary condenser should be to render the coil less efficient. On the theory due to Taylor-Jones, which was based upon the oscillation transformer—*i.e.* upon the resonance of two electrical circuits—a series of optimum values of primary capacity should occur. Both Rayleigh and Taylor-Jones put their theories to test by interrupting the primary circuit, by means of a rifle bullet, and both obtained results in accordance with their particular theories. The present authors attempt to reconcile these conflictory theories and tests upon the basis that the types of coil differed—*i.e.* that Rayleigh used a non-tuned induction coil similar to the oil-immersed coil of the previous abstract, whereas Taylor-Jones used a tuned coil similar to the intensified coil of the previous abstract. When using the tuned coil, the present authors find that the output is independent of the primary capacity over a wide range and the decay of current does not agree with the Taylor-Jones theory. Using the untuned oil-immersed coil, however, a definite capacity optimum appears to exist. The question is therefore still undecided. B. J. L.

1975. *A Differential Method for Deriving Magnetometer Deflection-Constants.* **H. W. Fisk** and **C. R. Duvall.** (Terrest. Magn. 30. pp. 1–10, March, 1925.)—For the computation of the horizontal component of the earth's magnetic field from the observed angle of deflection of one magnet by a second in Lamont's first position a factor, intrinsically a function of the dimensions of the magnets employed, is required to correct for these finite dimensions. The so-called "distribution-coefficients" concerned in this factor are generally determined by means of a rather tedious computation depending on the data observed at three deflection-distances. Theoretically the ratio of the sines (or the difference of the logarithmic sines) of the observed angles of deflection for any two distances is constant for a given instrument and pair of magnets; differential methods based on this theoretical condition are developed which simplify the computations required. The more exact form of the distribution-factor, $(1+Pr^{-2}+Qr^{-4})$, is found to be less satisfactory in practice than the simpler form $(1+P'r^{-2})$ for magnets which have been designed to make the value Q as small as possible (theoretically zero), on account of the greater sensitiveness to changes in the sine-ratios of the factor containing both P and Q. The paper includes numerical examples and tabulations to show the application of the derived formulas to the determination of distribution-coefficients, constants, and corrections on standard for a number of magnetic instruments of the Carnegie Institution of Washington. AUTHORS.

1976. *Quantum Magnetic Tubes in Rotation.* **H. S. Allen.** (Phil. Mag. 49. pp. 981–992, May, 1925.)—The properties of the three-dimensional discrete tubes of magnetic induction, corresponding to Faraday's "magnetic lines" [see Abstract 2962 (1924)], are discussed, with special reference to the setting up of an electrostatic field by the rotation of such quantum tubes. Their angular momentum and energy are analytically discussed, and the possible connection between a rotating magnetic tube and an electron is speculated upon. A. B. C. L.

1977. *The Magnetic Properties of Atoms and Molecules.* **B. H. Wilsdon.** (Phil. Mag. 49. pp. 1145–1164, June, 1925.)—In two previous papers the author has developed a theory of polar and non-polar chemical links, on the basis of quantum exchanges between valency orbits involving half numbers. Precessional or nutational movements of the orbits which form the chemical bond are supposed to synchronise the frequencies of the naturally untuned orbits, so that the total moment of momentum in opposite directions of the bond is equalised. Combining this idea with the principle of spatial quantising, definite and quantitative conclusions can be drawn as to the magnetic and stereometric properties of the molecule. The mathematical theory is developed, and tables are given showing agreement as good as can be expected between the theoretical and experimental values of the susceptibility, for a number of polar diamagnetic compounds, fairly good agreement for the diamagnetism of Cl, Br and I; a number of other elements are also considered, and the paramagnetic gases, oxygen and nitric oxide, where the theory developed, shows very fair agreement with the experimental results. **H. N. A.**

1978. *Artificial Magnetic Anistropy in Nickel.* **R. Forrer.** (Comptes Rendus, 180. pp. 1253–1255, April 27, 1925.)—The discontinuities in the magnetisation of iron discovered by Barkhausen [see Abstract 443 (1920)], and verified by van der Pol in the case of nickel also, may be observed by their effect on a telephone. The effect may be observed in nickel without employing an amplifier, which is required for iron. The author has verified this for an ordinary nickel wire, and finds that on stretching the wire the effect disappears almost completely. But if the wire is coiled round a 9-mm. cylinder and restraightened the effects are very much greater than for the wire in its initial state. Hysteresis curves drawn by an oscillographic method for a field of ± 20 gauss (see Fig.) indicate the differences between (*a*) annealed nickel, (*b*) nickel stretched to the breaking-point, and (*c*) nickel coiled up and restraightened. The portions *s* in curve (*c*) are caused by discontinuities, and they disappear if the nickel is heated above 700° C. **G. E. A.**



1979. *The Significance of Spectroscopic Magneton Numbers.* **E. C. Stoner.** (Phil. Mag. 49. pp. 1289–1309, June, 1925.)—The paper commences with a brief outline of the Landé-Sommerfeld schemes coordinating observations on the multiplet structure of spectral lines and their Zeeman-effect. The artificial and anomalous features in the attempted physical interpretations are pointed out. Simple cases are then considered, from which it is concluded that electron orbits and cores are characterised by integral magnetic moments (in terms of the Bohr unit). The magnetic moment of an electron orbit is given by its azimuthal quantum number. The maximum magnetic moment of a core is equal to the number of electrons it contains in uncompleted groups, and this determines the maximum term multiplicity (2 greater than the core moment). Magnet balancing in pairs of core electrons gives rise to lower multiplicities, all odd or all even for odd or even numbers of core electrons. The magnetic moments deduced spectroscopically are in agreement with those found directly in the Gerlach and Stern experiments, and the core values are simply correlated with the ionic moments deduced from susceptibility measurements. The question of angular moments, and the assignment of j values is discussed. Finally, it is shown that a consideration of the motion of the series electron in the magnetic field of the core leads to a general qualitative explanation of the physical significance of inverted terms and interval anomalies. Reference is made to Pauli's recent paper [see Abstract 1875 (1925)], which discusses several questions closely related to those here considered. H. H. Ho.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1980. *Influence of Radium upon Catalysis of the Liver.* **A. Maubert, L. Jaloustre** and **P. Lemay.** (Comptes Rendus, 180. pp. 1205–1207, April 20, 1925.)—Gives data of measurements in which the action of radium and radium emanation was ascertained upon the catalysing action of liver. The radium salt was the bromide and the action found to be essentially the same as that of thorium bromide, a small dose of either the salt or emanation in oxygen stimulating and a large dose paralysing the action. B. J. L.

1981. *A New Generator of 500,000-Volt Continuous Current.* **d'Arsonval,** with remarks by **J. Perrin.** (Comptes Rendus, 180. pp. 1549–1554, May 25, 1925.)—Describes combinations of kenotrons and capacities which are utilised by Perrin to obtain 15 kw. of high-tension energy at 500 kv. and 30 milliamperes. Other arrangements permit of obtaining 600 kv. and still higher continuous current voltages. These follow in principle the well-known " constant current " X-ray apparatus for voltages up to 250 kv. as now used in radiological practice, for example by the French firm Gaiffe, Gallot and Pilon, and do not need extended description. In a note Perrin comments upon the possibility of transmutation of atoms with voltages in the neighbourhood of 5,000,000 volts. B. J. L.

1982. *The Significance of Electro-cardiographs.* **F. Henrijean.** (Comptes Rendus, 180. pp. 1703–1706, June 2, 1925.)—The article is of physiological rather than physical importance, and deals with the cause of the well-known P and R waves which may be observed with non-beating heart muscle. The actions of various drugs are described in relation to this phenomenon and with reference to antagonistic action. The author concludes that in heart muscle the contraction is electromotive in origin, not under the control of a motor nerve, but under the control of the heart nodes, and particularly the node of Tawara. This electromotive force is due to electrocapillary phenomenon, and gives rise to the curve of non-beating heart muscle, whereas the curve of beating heart muscle has two components, namely, the primitive curve of the muscle and the negative curve due to muscular contraction. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1983. *Gas-Sorption.* **D. H. Bangham** and **W. Sever.** (Phil. Mag. 49. pp. 935–944, May, 1925.)—The equation $d \log s/d \log t = \text{const.} \left(\frac{1}{m}\right)$, for the early stages of sorption on glass surfaces is confirmed over a range of sorption values from about 6 to 1; $(1/m)$ is very sensitive to the past history of the glass and probably to traces of impurity. Beyond the range of obedience to the above equation a formula $\log \{\sigma/(\sigma - s)\} = kt^{1/m}$ is closely followed, where σ is the limiting value of s as s approaches infinity; this approximates to the former equation for small values of s and t. Equations of this type appear applicable in a large number of cases where a gas becomes a solid or *vice versa.* The phenomena occurring are not restricted to the boundary layer, but involve a transport of matter through the solid medium, not following the laws of diffusion.

A. D.

1984. *The Causes and Effects of Corrosion.* (Indust. and Engin. Chem. 17. pp. 335–392, April, 1925. Chem. and Met. Eng. 32. pp. 432–434, April, 1925.)—A number of papers are contributed to the discussion of corrosion at a symposium at the Baltimore Meeting of the American Chemical Society on April 8 to 10, 1925, under the chairmanship of R. J. McKay. **W. M. Corse** gives a description of the function of the Corrosion Committee of the American Chemical Society and a summary of outstanding directions of recent progress. **W. D. Bancroft,** in a paper on "Corrosion in Aqueous Solution," deals with the subject mainly with reference to its bearing on electrolytic corrosion. It is shown that the action is increased largely by the presence of oxygen which acts as a depolariser of electrolytically deposited hydrogen. The intermediate formation of hydrogen peroxide has been recognised. The inhibiting action of alkaline solutions on the rusting of iron is attributed to the formation of an oxide film. Other papers are by **F. N. Speller** on "Corrosion Factors and the Electrochemical Theory"; **W. H. Bassett** and **H. A. Bedworth** on "Accelerated Corrosion Tests of Copper-Zinc Alloys by Salt Spray"; **W. G. Whitman** and **R. P. Russell** on "The Acid Corrosion of Metals"; **R. E. Wilson** and **W. H. Bahlke** on "Special Corrosion Problems in Oil Refining"; **A. C. Zimmerman** on "The Corrosion of some Cast Aluminium Alloys"; **U. R. Evans** on "Oxygen Distribution as a Factor in the Corrosion of Metals"; **N. B. Pilling** and **R. E. Bedworth** on "The Oxidation of Copper-Nickel Alloys at High Temperatures"; **W. E. Pratt** and **J. A. Parsons** on "The Practical Use of Laboratory Corrosion Tests." An investigation by **J. W. Shipley, I. R. McHaffie** and **N. D. Clare** shows that the corrosion of iron in the absence of oxygen is proportional to the H ion concentration down to a *p*H value of 9·4 when hydrogen evolution and solution of iron ceases. A paper by **W. R. Whitney** on "Corrosion of Iron" describes experiments in which the wearing away or cutting of iron by water in motion in presence of air is followed. It is concluded that the removal of the metal is probably preceded by a chemical corrosion. In a paper by **G. W. Morey**

on "The Corrosion of Glass Surfaces," the mechanism of the corrosion and the effect of various oxides on the resistivity of glass are outlined. J. N. P.

1985. *The Effect of Various Factors upon the Velocity of Crystallisation of Substances from Solution.* **J. D. Jenkins.** (Am. Chem. Soc., J. 47. pp. 903–922, April, 1925.)—A Zeiss dipping refractometer was employed, the prism being placed directly in the solution; seed crystals were dropped into the solution, which was stirred by means of an electric motor; a chronograph was employed in recording the readings of the refractive index of the liquid as crystallisation proceeded. By using interchangeable prisms the value of the refractive index may be as high as 1·45. The effects of various foreign substances, initial supersaturation and added solvents were studied with urea and with naphthalene dissolved in methyl alcohol. The viscosity of the solution was an important factor with mixed solvents. A thermometric method for the determination of the velocity of crystallisation, in cases where the first method could not be employed, is described, and the results of a number of measurements are given and discussed in relation to some of the existing theories of crystallisation. The temperature coefficient of the velocity of crystallisation of acetanilide in two solutions is due only to the decrease in viscosity of the solutions with increase of temperature. Some determinations of the rate of solution have been made, and a formula has been suggested and tested for the rate of solution of small crystals in a medium whose volume is so great that its concentration is not appreciably altered during the process. H. N. A.

1986. *Stability of Colloidal Solutions. III. Influence of Negative Ions, the Effect of Dilution and Ageing and the Influence of Capillary Active Non-Electrolytes on the Coagulation of Copper Ferrocyanide Sol.* **K. C. Sen.** (J. Phys. Chem. 29. pp. 517–539, May, 1925.)—A continuation of previous work done upon the stability of colloidal solutions [Abstract 692 (1925)]. The coagulation of copper ferrocyanide sol by electrolytes was studied under different conditions, and it was shown that the colloid obeys the Schultze-Hardy law. Dilution of the sol makes it more stable towards mono- and bi-valent coagulating ions and less stable towards tri- and quadri-valent ions. The effect of ageing in the case of copper ferrocyanide sol is considerable, and the sol becomes more stable towards all electrolytes on standing. The view is put forward that in the majority of cases studied the antagonistic effect between pairs of salts is really due to the stabilising effect of the ions charged oppositely and that of the precipitating ion. In no case has the antagonistic action been definitely proved to be purely cationic. F. J. B.

1987. *Sign of Electrical Layer Farthest Away from the Surface of a Solution in Contact with Air or a Metal.* **R. D. Kleeman** and **C. R. Pitts.** (J. Phys. Chem. 29. pp. 508–516, May, 1925.)—Small bubbles of air were produced at the bottom of a vertical glass tube containing a solution of a salt or an acid. The motion of the bubbles up the tube gave rise to a fall of potential along the tube whose direction was measured by two electrodes connected to a galvanometer. The fall of potential was assumed to be produced by a "peeling off" of the electrical charges from the electrical double layers associated with the liquid surfaces of the bubbles. More than fifty solutions were examined. No simple relationship seemed to exist between the nature of the solution and the size of this layer. A tangential motion given to the liquid near one of the electrodes would tend to "peel off" the outermost layer of electricity, and set up a corresponding difference of potential between the electrodes, from which the sign of the layer farthest from the metal could be determined. The layer was found to be always negative when the solution consisted of a salt of the same metal as the electrodes. For platinum electrodes the sign was sometimes positive, sometimes negative, and no simple relationship to the composition was observed. F. J. B.

1988. *Equilibrium Conditions for Metallic Alloys in Liquid and Solid States with an Application to Gold-Silver Alloys.* **V. Fischer.** (Zeits. techn. Physik, 6. 3. pp. 103–107, 1925.)—A mathematical statement of the equilibrium conditions of an alloy of two metals with application to gold and silver alloys. These conditions are then developed so as to apply to an alloy of any number of metals. [See Abstract 613 (1925).] E. H. B.

1989. *Passivity.* **H. Gerding** and **A. Karssen.** (Zeits. Elektrochem. 31. pp. 135–143, March, 1925.)—A survey of the various theories—purely physical, purely chemical, and physico-chemical—which have been propounded to explain the passivity of iron, etc. At present the theory of **Smits** (Die Theorie der Allotropie, Leipzig, 1921 ; K. Akad. Amsterdam, Versl. 22. p. 642, 1913 ; 27. pp. 1,811, 981, 1407, 1918–1919 ; Ph. Ch. 88. p. 743, 1914 ; 90. p. 723, 1915 ; 92. p. 1, 1916 ; Zeits. Elektrochem. 30. p. 214, 1914, seems to hold the field. A. D.

1990. *An Electronic Theory of the Passivity of Metals.* **U. Sborgi.** (Accad. Lincei, Atti, 1. pp. 315–318, March 15, 1925.)—The author tries to demonstrate that the passivity of some metals is due to their electronic constitution. According to this constitution the metals can be divided into three classes ; (1) Those of constant valence constituted by a nucleus of constant composition, which is that of the rare gas from which they are derived ; (2) those of variable valence in which the nucleus is already that of the rare gas from which the subsequent class is started ; and (3) metals both of variable valence and nucleus. The special considerations on the electronic constitution of metals cannot be abstracted and should be read in the original article. E. B.

1991. *An Electronic Theory of the Passivity of Metals.* **U. Sborgi.** (Accad. Lincei, Atti, 1. pp. 388–392, April 4, 1925.)—This article is the natural continuation of a former one [see preceding Abstract] and demonstrates that the phenomena of the passivity of metals are due to their electronic constitution. E. B.

1992. *Interaction of Carbon Dioxide and Hydrogen in the Corona due to High-frequency Alternating Currents.* **R. W. Lunt.** (Roy. Soc., Proc. 108. pp. 172–186, May 1, 1925.)—The experiments described were carried out with alternating currents of frequency $1 \cdot 5 \times 10^7$ obtained from a valve generator. The gases were contained in a quartz vessel like a Siemens ozoniser, and could be streamed through and collected for analysis. At the above frequency approximately equimolecular mixtures of carbon dioxide and hydrogen interact in the corona giving a water-gas equilibrium which has been examined over a limited pressure range. The same equilibrium point is reached, whether the reaction is confined to the small quantity of gas in the quartz vessel, or whether the gases are streamed through. The proportion of CO_2 in the initial mixture was varied from 11 % to 100 %. In the range below 50 % some of the monoxide was found to be reduced, principally to methane; but in no case was any formaldehyde or formic acid detected, as found by Moser and Isgarischew at a frequency of 50 cycles per sec. [Abstract 1358 (1910)]. Preliminary experiments indicate that the equilibrium point is independent of the voltage applied to the gas. A. W.

1993. *Behaviour of Hydrogen in the High-frequency Corona Discharge.* **R. W. Lunt.** (Phil. Mag. 49. pp. 1238–1249, June, 1925.)—The apparatus employed was the same as that used for investigating the interaction of CO_2 and hydrogen [see preceding Abstract] and the frequency used was again $1 \cdot 5 \times 10^7$. An analysis of the Siemens ozoniser is first given, which affords a ready determination of the voltage gradient and of the current carried by the ions in the gas. The results obtained in five series of experiments at different pressures between 10 and 50 cm. of mercury are then given. For each pressure the power supplied to the oscillating circuit was varied over the range 150 to 400 watts, and diagrams are given showing (1) the ionisation current, (2) the ratio of the voltage gradient to the gas-pressure, and (3) the ratio of the mean ionisation to the number of molecules per c.c., for the various pressures and powers used. A. W.

1994. *Electrode Potentials and Free Energy of Solvation.* **J. Heyrovský.** (J. Phys. Chem. 29. pp. 406–409, April, 1925.)—In a previous paper [Abstract 1769 (1925)], the electrode potentials π of galvanic cells were deduced from the ionisation potential I_1 of the electrode vapour, or the electro affinity E_1 of a metalloid, the vapour tension of the electrode P, the free energy of solvation, H, of the electrode ions, and the concentration of the solvated ions. The formulæ

$$\pi_{\mathrm{Me}} = - \mathrm{RT/F} \log \mathrm{P_{Me}} + \mathrm{I} - \mathrm{H_{Me}} + \mathrm{RT/F} \log [\mathrm{Me}^{\cdot}_{\mathrm{sol}}]$$

and $$\pi_x = + \mathrm{RT/F} \log \mathrm{P}_x + \mathrm{E} + \mathrm{H}'_x - \mathrm{RT/F} \log [\chi'_{\mathrm{sol}}]$$

were obtained. It was shown that the electrode potential depends not only on the number of ions in solution, but also on their degree of solvation and therefore on the vapour pressure of the solution. In this way the "activity coefficients" can be expressed by means of the free energy of solvation, and the view is supported by experimental facts.

F. J. B.

1995. *Effect of Small Alternating Currents on Polarised Electrodes.* **S. Glasstone.** (Am. Chem. Soc., J. 47. pp. 940–945, April, 1925.)—Investigates the action of small alternating currents on an electrode polarised by direct current, under such conditions that no reverse current ever flows through the electrolytic cell during the course of a whole cycle. Many of the potentials given in the literature, which purport to indicate the influence of alternating currents on over-voltage, are of doubtful value. Only in a limited number of cases does alternating current of small amplitude reduce the polarisation at electrodes in N sulphuric acid and N sodium hydroxide solutions. The effect of alternating current in reducing over-voltage in some cases is discussed. A. D.

1996. *Experimental Studies on the Hydrogen Electrode.* **H. T. Beans** and **L. P. Hammett.** (Am. Chem. Soc., J. 47. pp. 1215–1226, May, 1925.)—The results are given of comparative polarisation measurements with smooth and platinised platinum electrodes. Bright metallic deposits of platinum prepared electrolytically from a solution of purified chloroplatinic acid are found to be catalytically active for the H_2 – H ion reaction. The main difficulty in their use is found to arise from the tendency of the platinum to occlude substances of an acid nature and to give up the occluded acid, slowly but continuously. The formation of Pt-black electrolytically from chloroplatinic acid is attributed to the presence of some impurity. The speed of attainment of equilibrium of hydrogen electrodes is found to be proportional to the freedom of the electrolyte from oxygen. In alkaline solutions the influence of oxygen is much greater than in acid solutions. It is found possible to make hydrogen electrode measurements in unbuffered solutions in the mutual range, provided the electrodes are clean. J. N. P.

1997. *A Method of Studying Electrode Potentials and Polarisation.* **H. D. Holler.** (Bureau of Standards, Sci. Papers No. 504. pp. 153–166, 1925.)—A resistance-coupled electron-tube amplifier was used to operate an oscillograph for observing and recording the variations in potential of several electrodes without requiring any current from the electrode under investigation. By superposing alternating current upon the electrode it was possible with the use of a separately excited wattmeter to measure the potential due to resistance, and compute the boundary resistance at the electrode. The paper is limited to a description of the method and illustrations of its use in the case of some typical electrodes, including both smooth and platinised platinum, carbon, lead, and copper in sulphuric acid, and copper in a copper sulphate solution. AUTHOR.

1998. *Influence of Acidity upon the Galvanic Polarisation of Nickel.* **S. Triandafil.** (Comptes Rendus, 180. pp. 737–739, March 9, 1925.)—On account of the position of nickel with respect to hydrogen in the series of electrochemical potentials its kathodic separation in ordinary conditions of electrolysis is nearly always accompanied with that of hydrogen. It therefore is of interest to know what is the influence of hydrogen upon the galvanic polarisation of nickel. As the results of the present experiments it appears that the two factors, acidity and temperature, act in the same sense upon the galvanic polarisation of nickel; an increase of acidity or an elevation of temperature lowers the polarisation. There is a predominance of temperature-effect, when the two effects are considered simultaneously, in the interval $P_H = 0$ to $P_H = 7$. In particular at 75° and 100° the influence of acidity is almost negligible. A. E. G.